Ontario

Ministry of Transportation

Materials Engineering and Research Office Report

Aggregate and Soil Proficiency Sample Testing Program for 2009

MERO-036

Ontario

Ministry of Transportation

Materials Engineering and Research Office Report

Aggregate and Soil Proficiency Sample Testing Program for 2009

MERO-036

Technical Report Documentation Page

Publication Title	**Aggregate and Soil Proficiency Sample Testing Program for 2009**
Author(s)	Mark Vasavithasan, Stephen Senior
Originating Office	Soils and Aggregates Section, Materials Engineering and Research Office
Report Number	MERO-036; ISBN: Print: 978-1-4435-1811-6; PDF: 978-1-4435-1812-3
Publication Date	January 2010
Ministry Contact	Soils and Aggregates Section, Materials Engineering and Research Office Highway Standards Branch, Ontario Ministry of Transportation Room 220, Building C, 1201 Wilson Avenue Downsview, Ontario, Canada M3M 1J8 Tel: (416) 235-3735; Fax: (416) 235-4101

Abstract

The Materials Engineering and Research Office, Soils and Aggregates Section, conducts a proficiency sample-testing program each year to provide a means for participating laboratories to see if they are performing satisfactorily. We also conduct a sample testing program for the tests related to Superpave consensus properties of aggregates. This is conducted along with our annual Aggregate and Soil Proficiency Sample Testing Program.

The laboratories are asked to perform a number of different tests on pairs of samples that have been prepared and randomly selected at the MTO Laboratory. The samples are delivered to the participating laboratories starting in June, and they report their results for the aggregate and soil proficiency sample tests starting in mid-August. A preliminary report issued in mid-September allows the laboratories to examine their procedures or equipment and correct any problems that may have occurred.

This is the final report for both the Aggregate and Soil Proficiency Samples and Superpave Consensus Property Testing for 2009. This year, two hundred and twenty laboratories from the private and public sector participated in the Aggregate and Soil Proficiency Sample Testing Program. Fifty-seven laboratories from the private sector and MTO Downsview laboratory reported results for all four of the Superpave consensus property tests.

Results of the aggregate and soil tests from the 2009 program are found to be consistent with the results reported in the last three years, but, in some of the tests, the variations show noticeable improvements compared to previous years' results. Although there is improvement in results, strong laboratory biases still remain in many of the test procedures.

We expect that the lab inspection process and quality control program implemented by CCIL will bring about improvements in multi-laboratory variation.

Key Words	Aggregate, consensus property, correlation, laboratory, proficiency testing, soil, Superpave
Distribution	Unrestricted technical audience.

Ontario

Ministry of Transportation
Materials Engineering and Research Office Report

MERO-036

Aggregate and Soil Proficiency Sample Testing Program for 2009

January 2010

Prepared by:
Mark Vasavithasan and Stephen Senior
Materials Engineering and Research Office
Soils and Aggregates Section
Ontario Ministry of Transportation

1201 Wilson Avenue
Downsview, Ontario, Canada M3M 1J8
Tel: (416) 235-3735; Fax (416) 235-4101

Table of Contents

List of Tables

List of Figures

Executive Summary

The Soils and Aggregates Section of the Materials Engineering and Research Office runs an annual proficiency sample testing program for aggregate and soil tests. This program provides a means for participating laboratories to see if they are performing satisfactorily. The laboratories are asked to perform a number of different tests on pairs of samples that have been prepared and randomly selected by the MTO Soils and Aggregates Laboratory. The samples are delivered to the participating laboratories starting in June. The laboratories report their results in the second week of August. A preliminary report issued in mid-September gives feedback to the participants while they are still operational in the current year. This allows them to examine their procedures or equipment and correct any problems that may have occurred. A final report is issued after analysis of the data has been completed.

This is the final report for the 2009 MTO Aggregate and Soil Proficiency Sample Testing and the Superpave Aggregate Consensus Property Testing Programs. Proficiency test samples in duplicates were shipped to two hundred and twenty-six private and public sector laboratories. Two hundred and twenty of the laboratories that requested samples submitted test results in 2009. Of these, one hundred and sixty were aggregate producers' and road builders' Quality Control (QC) laboratories. The remainder were engineering testing consultants' and owners' laboratories. Participation in this program is required by the contract documents if the contractor's QC process is to be acceptable to MTO. In general, these contractor and supplier laboratories are conducting particle size analysis, wash pass 75 µm, percent crushed particles, percent asphalt coated particles, percent flat and elongated and density tests for granular base and sub-base aggregates.

In 2009, sixty-six laboratories reported results for the tests related to Superpave aggregate consensus properties. The laboratories that participate in this program conduct uncompacted void content of fine aggregate, sand equivalent value of fine aggregate, percent of fractured particles in coarse aggregate, and flat particles, elongated particles, or flat and elongated particles in coarse aggregate tests, in accordance with the ASTM/AASHTO test methods.

Reports to individual laboratories contain ratings for each test method, which are based on the standardized deviate for that test (i.e. a rating of 5 for data within 1.0 standard deviation of the mean, a rating of 0 for data 3.0 or more standard deviations from the mean). Ratings of each test method are also used to calculate an overall laboratory rating for each category of tests. This rating system has acted as an incentive for laboratories to improve their performance. The rating is also used as a guide by MTO to select laboratories for its quality assurance testing and for qualifying referee laboratories.

Results of the aggregate and soil tests from the 2009 program are found to be consistent with the results from previous years and, in some of these tests, the results show improvements compared to previous years' results and precision estimates published by AASHTO, MTO, or ASTM. Particularly, sieve analysis of coarse aggregate, percent flat and elongated

particles of coarse aggregate, relative density and absorption of coarse and fine aggregates, Magnesium sulphate soundness ($MgSO_4$) of coarse aggregates, and freeze-thaw loss show improvements over the precision estimates published by ASTM or MTO. Although the precision of most of the test methods compares favourably in relation to the results of previous studies and the precision estimates where available, strong laboratory biases still remain in some of the test methods. The variations in soil test results are consistent with the values reported in the previous three years of study, but the scatter plots show a strong laboratory bias.

The results of Superpave consensus property tests from the 2009 program do not compare favourably with the past performance of the laboratories. The variations of only one of the tests in the program were found to be lower than that of the values published in ASTM precision statements. The scatter diagrams for the Superpave tests also show strong laboratory biases.

The Soils and Aggregates Section continues to carry out the inspection of laboratories providing soil testing services to the ministry. This inspection is being done at the request of laboratories. The laboratories that are inspected and accepted by MTO must request a re-inspection whenever technicians or equipment change. To date, thirty-nine laboratories have been inspected, of which thirty-three laboratories are on the MTO Vendors List to do testing of soils for MTO work.

1. Introduction

This is the final report of the 2009 interlaboratory testing program organized by MTO for aggregate and soil test methods. It is primarily intended to provide a means for laboratories used by MTO to see if they are performing satisfactorily and to qualify these laboratories to perform quality control and quality assurance testing for MTO contracts[1]. The design of the testing program is based on procedures for determining the precision and variability of test methods. Interested readers should refer to ASTM C670[2], C802[3], E177[4], and E178[5] for further information on interlaboratory testing programs.

A total of two hundred and twenty laboratories participated in the Aggregate and Soil Proficiency Sample Testing Program conducted in the summer of 2009. The participants were also asked to submit results for Superpave aggregate consensus property tests, if they were equipped to perform those tests. Fifty-eight laboratories submitted results for all of the tests related to the consensus properties. Participants in both testing programs included the MTO laboratory, the remainder being from the private sector (contractors, aggregate producers, and engineering consultants) and municipalities. Samples were delivered to laboratories in early June. A preliminary report was issued to the participants in mid-September.

Reports to individual laboratories contain ratings for each test method, which are based on the standardized deviate for that test (i.e. a rating of 5 for data within 1.0 standard deviation of the mean, a rating of 0 for data 3.0 or more standard deviations from the mean). Ratings of each test method are also used to calculate an overall laboratory rating. This rating system has acted as an incentive for laboratories to improve their performance.

The computer program that was developed by MTO to handle the computation and presentation of test data has two statistical methods, namely the Critical Value Method and the Iterative (Jackknife) Technique, to detect outlying observations or outliers in a set of data. For details of the program, refer to the User's Manual (report MERO-013) by Vasavithasan and Rutter, 2004. A number of statistical methods are available to test the hypothesis that the suspect observations are not outliers, but the MTO study follows the Critical Value Method recommended in Section 4 of ASTM E178. The critical value method and iterative techniques are based on two different statistical approaches. As a result, the confidence intervals yielded by these two methods differ widely depending on the number of observations (number of laboratories participating in a particular test method) and the distribution of data.

The critical value used in this study is that value of the sample criterion, which would be

1 Laboratories must also be inspected and recognized by the Canadian Council of Independent Laboratories (CCIL).
2 ASTM C670 Practice for Preparing Precision and Bias Statements for Test Methods of Construction Materials.
3 ASTM C802 Practice for Conducting an Inter-laboratory Test Program to Determine the Precision of Test Methods of Construction Materials.
4 ASTM E177 Practice for Use of Terms Precision and Bias in ASTM Test Methods.
5 ASTM E178 Practice for Dealing with Outlying Observations.

exceeded by chance with some specified probability (significance level) on the assumption that all observations in the sample come from the same normally distributed population. The critical values provided in ASTM E178, Table 1 are limited to 147 observations, but over 200 laboratories participate in our annual testing program. The critical values that are being used for the MTO study were calculated at five percent significance level (Grubbs' test) based on Grubbs' (1969 and 1972) recommendations for identifying outliers. The jackknife method recommended by Manchester (1979) is used where the strict application of the critical value method tends to include results that may not stand the best chance of representing the testing performed in conformance with each of the test methods.

2. Test Results

2.1 TABLE OF TEST RESULTS

Each participant receives an individual summary of results for their laboratory. An example of a typical report is shown in Tables 1, 2, 3, and 4. Each Table of Results identifies the laboratory by number and compares the laboratory's data with the means obtained after statistical analysis of the data received from all laboratories. The identity of the laboratories is kept confidential.

Column 1 gives the test method as designated in the MTO Laboratory Testing Manual.

Columns 2 and 3 show the test data submitted by the laboratory for a pair of samples.

Columns 4 and 5 show the mean (average) test value for each sample, for all laboratories performing the test, after removal of outliers and/or invalid test data.

Columns 6 and 7 list the standardized deviate for each test result. The standardized deviate is used to show how the individual test results compare to the mean. It is obtained by subtracting the mean of all data ($\overline{X}$) from the actual test result reported by the laboratory (X_i) and dividing by the standard deviation (s). That is:

$$\text{Standardized deviate} = \frac{\left(X_i - \overline{X}\right)}{s}$$

If the test result is less than the mean, the standardized deviate is negative and, if the test result is greater than the mean, the standardized deviate is positive. In brief, the standardized deviate tells us how many standard deviations the test result is away from the mean.

Columns 8 and 9 list the test method ratings, which are similar to the standardized deviate, but are in a simple numeric form. Ratings are determined as follows:

Rating 5 - data within 1.0 standard deviation of the mean.
Rating 4 - data within 1.5 standard deviations of the mean.
Rating 3 - data within 2.0 standard deviations of the mean.
Rating 2 - data within 2.5 standard deviations of the mean.
Rating 1 - data within 3.0 standard deviations of the mean.
Rating 0 - data 3.0 or more standard deviations from the mean or data considered to be outlying by other methods.

A negative sign simply indicates a result that is smaller than the mean. If one of the paired test results for a given test is excluded based on the outlier criteria, the other test result is still subjected to the statistical analysis and is only excluded if it also fails to meet the criteria.

An outlying observation is one that appears to deviate markedly from the sample population. It may be merely an extreme manifestation of the random variability inherent in the data, or may be the result of gross deviation from the prescribed experimental procedure, calculation errors, or errors in reporting data. The outlier criteria employed for exclusion of test results from the analysis will depend on the distribution of data and the number of participants in a test. The iterative technique is one of the methods employed in this study for the selection of outliers, and is used where the strict application of critical value method tends to include the data that does not belong to the population. In the critical value method, the standardized deviate of a lab result is compared with the critical value corresponding to the number of participants in that particular test for rejecting an outlier. The critical value is greater than 3 when the number of participants in a particular test method is 30 or more. For this reason, results with more than 3 standardized deviates may not have been identified as an outlier unless it is higher than the critical value, but a zero rating is nevertheless assigned for the test result in question. For example, if the computed standardized deviate for a lab result is 3.236 and the critical value corresponding to the number of participants in that particular test is 3.427, the lab will not be identified as an outlier but a zero rating will be assigned.

Significance need not necessarily be attached to a single low rating. However, a continuing tendency to get low ratings on several pairs of samples or on a series of tests from one procedure (e.g. sieve analysis) should lead a laboratory to re-examine its equipment and test procedure. A laboratory that reports data for a specific test consistently lower or higher than the mean over a number of test periods also needs to re-examine their test procedure, because this is evidence of a systematic bias in how the laboratory conducts the procedure. Any computer program that is used by a laboratory to calculate test results should be verified as part of this examination.

2.2 SCATTER DIAGRAMS

Youden scatter diagrams are supplied with this report (see Appendices D1 and D2). A laboratory can locate itself on the diagrams by plotting its test value for the first sample (1.09) on the horizontal axis, against its test value for the second sample (2.09) on the vertical axis. The horizontal and vertical axes are of equal length and are scaled to give the most informative display of the plotted points. In some cases, the outlying results plot outside the boundaries of the diagram. If the results from two or more laboratories happen to coincide, a single point is plotted.

Below each scatter diagram, the test number and title are given, followed by a table of statistical calculations for both samples. Here the mean, median, and standard deviation for each sample are given. The number of laboratories reporting valid data and the laboratories eliminated by statistical analysis are also listed.

The vertical and horizontal crosshairs on the plots represent the mean values for all the results on the first sample (1.09) and the second sample (2.09), respectively. These lines divide the diagram into four quadrants, numbered 1 through 4, beginning in the upper right-hand quadrant and continuing clockwise. In an ideal situation where only random errors occur, the points are expected to be equally numerous in all quadrants and will form a circular distribution. This follows because plus and minus errors should be equally likely.

Often, however, the points tend to concentrate in quadrants 1 and 3 on the diagram. This occurs because laboratories tend to get high or low results on both samples. This gives evidence of individual laboratory biases. As the tendency to laboratory bias increases, the departure from the expected circular distribution of points towards a linear distribution from quadrant 1 to 3 occurs. Such a distribution of points indicates systematic variation. Figure 1 gives examples of scatter diagrams.

Table 1. Summary of Results for Laboratory 47

TEST RESULTS FOR LABORATORY NUMBER 47 DATE PREPARED: November 9, 2009

COARSE AGGREGATE REFERENCE SAMPLES 1.09 & 2.09

TEST METHOD	LABORATORY DATA		MEAN OF LABORATORIES		STANDARDIZED DEVIATE		LAB RATING	
	1.09	2.09	1	2	1	2	1	2
LS-601 Wash Pass 75 µm (Coarse Agg.)	1.760	1.690	1.969	1.901	-0.878	-0.836	-5	-5
LS-602 – Coarse Aggregate								
Percent Passing 19.0 mm	98.300	98.100	98.867	98.888	-1.556	-2.444	-3	-2
Percent Passing 16.0 mm	94.300	94.300	94.814	94.771	-0.814	-0.723	-5	-5
Percent Passing 13.2 mm	90.300	90.100	90.702	90.760	-0.575	-1.005	-5	-4
Percent Passing 9.5 mm	83.300	83.200	83.672	83.871	-0.436	-0.944	-5	-5
Percent Passing 4.75 mm	71.820	72.040	72.327	72.633	-0.608	-0.776	-5	-5
LS-603 Los Angeles Abrasion, %	24.400	24.400	25.780	26.164	-1.005	-1.033	-4	-4
LS-607 Percent Crushed Particles	58.700	51.500	56.924	57.175	0.257	-0.803	5	-5
LS-608 % Flat & Elongated Particles	7.200	6.300	5.529	5.255	0.730	0.493	5	5
LS-609 Petrographic Number (Concrete)	136.40	134.00	120.2	119.9	2.115	2.340	2	2
LS-614 Freeze-Thaw Loss, %	9.900	10.300	12.116	11.786	-1.026	-0.790	-4	-5
LS-618 Micro-Deval Abrasion Loss (CA)	12.900	13.400	13.042	13.167	-0.152	0.216	-5	5
LS-620 Accelerated Mortar Bar (14 Days)								

Blank spaces represent not tested.
* - Calculation considered outlier

Table 2. Summary of Results for Laboratory 47

TEST RESULTS FOR LABORATORY NUMBER 47 DATE PREPARED: November 9, 2009

FINE AGGREGATE REFERENCE SAMPLES 1.09 & 2.09

TEST METHOD	LABORATORY DATA		MEAN OF LABORATORIES		STANDARDIZED DEVIATE		LAB RATING	
	1.09	2.09	1	2	1	2	1	2
LS-623								
Maximum Wet Density (g/cm^3)	2.142	2.167	2.176	2.180	-1.155	-0.356	-4	-5
Maximum Dry Density (g/cm^3)	1.942	1.968	1.979	1.982	-0.998	-0.348	-5	-5
Optimum Moisture, %	10.300	10.100	10.037	10.040	0.597	0.124	5	5
LS-604 – Coarse Aggregate								
Relative Density (O.D.)	2.688	2.686	2.690	2.691	-0.399	-0.816	-5	-5
Absorption	0.400	0.410	0.393	0.389	0.116	0.334	5	5
LS-621								
Asphalt Coated Particles, %	27.500	28.300	27.291	27.169	0.045	0.298	5	5

Blank spaces represent not tested.
* - Calculation considered outlier

Table 3. Summary of Results for Laboratory 47

TEST RESULTS FOR LABORATORY NUMBER 47 DATE PREPARED: November 9, 2009

FINE AGGREGATE REFERENCE SAMPLES 3.09 & 4.09

TEST METHOD	LABORATORY DATA		MEAN OF LABORATORIES		STANDARDIZED DEVIATE		LAB RATING	
	3.09	4.09	3	4	3	4	3	4
LS-605 – Fine Aggregate								
Relative Density (O.D.)	2.687	2.693	2.686	2.687	0.090	0.612	5	5
Absorption	0.960	0.870	0.940	0.940	0.150	-0.539	5	-5
LS-606 – Coarse Aggregate								
$MgSO_4$ Soundness Loss, %	9.200	9.500	8.871	9.008	0.122	0.247	5	5
LS-606 – Fine Aggregate								
$MgSO_4$ Soundness Loss, %	-	-	-	-	-	-		-
LS-619 – Fine Aggregate								
Micro-Deval Abrasion	12.500	12.500	13.253	13.207	-0.707	-0.584	-5	-5
LS-602 – Fine Aggregate								
Percent Passing 2.36 mm	62.600	63.200	63.447	63.534	-0.653	-0.207	-5	-5
Percent Passing 1.18 mm	52.600	53.400	52.514	52.627	0.048	0.371	5	5
Percent Passing 600 μm	37.400	38.600	37.877	37.839	-0.229	0.326	-5	5
Percent Passing 300 μm	19.700	20.700	19.630	19.689	0.052	0.595	5	5
Percent Passing 150 μm	9.600	10.200	9.723	9.842	-0.168	0.401	-5	5
Percent Passing 75 μm	5.800	6.300	5.950	6.017	-0.354	0.633	-5	5

Blank spaces represent not tested

* - Calculation considered outlier

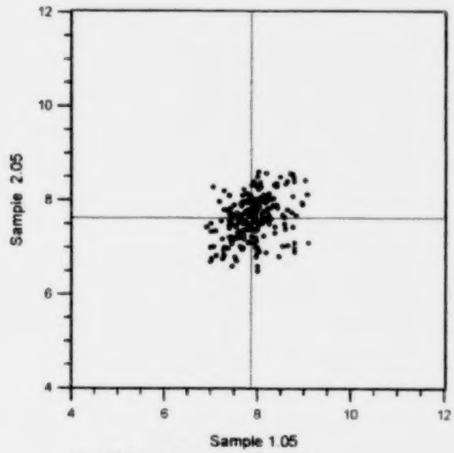
Table 4. Summary of Results for Laboratory 47

TEST RESULTS FOR LABORATORY NUMBER 47 DATE PREPARED: November 9, 2009

SOILS REFERENCE SAMPLES 5.09 & 6.09

TEST METHOD	LABORATORY DATA		MEAN OF LABORATORIES		STANDARDIZED DEVIATE		LAB RATING	
	5.09	6.09	1	2	1	2	1	2
LS-702 – Sieve Analysis of Soil								
Percent Passing 2.00 mm	99.900	99.900	99.972	99.963	-0.427	-0.346		
Percent Passing 425 μm	97.700	97.900	97.224	97.070	0.904	1.405	5	4
Percent Passing 75 μm	93.600	93.600	91.834	91.452	1.741	2.341	3	2
Percent Passing 20 μm	76.000	72.600	79.155	78.500	-0.812	-1.666	-5	-3
Percent Passing 5 μm	54.100	55.100	58.914	58.794	-1.354	-1.057	-4	-4
Percent Passing 2 μm	42.700	39.800	44.377	43.980	-0.569	-1.347	-5	-4
LS-703 Liquid Limit, %	37.600	37.200	36.893	36.667	0.535	0.317	5	5
LS-704 Plastic Limit, %	18.900	18.700	18.910	18.784	-0.008	-0.065	-5	-5
Plasticity Index, %	18.700	18.500	17.940	17.850	0.389	0.318	5	5
LS-705 Specific Gravity of Soil	2.781	2.764	2.734	2.735	1.483	0.978	4	5
AGGREGATE CONSENSUS PROPERTIES								
Uncompacted Void Content	42.700	42.900	41.967	41.924	1.080	1.749	4	3
Sand Equivalent Value	68.000	68.000	69.404	68.726	-0.274	-0.136	-5	-5
Percent Fractured Particles	75.200	<u>81.200</u>	58.344	<u>58.780</u>	2.457	<u>3. 812</u>	2	0
% Flat & Elongated Particles	0.600	0.300	1.100	1.016	-0.737	-1.068	-5	-4

Blank spaces represent not tested.
* - Calculation considered outlier

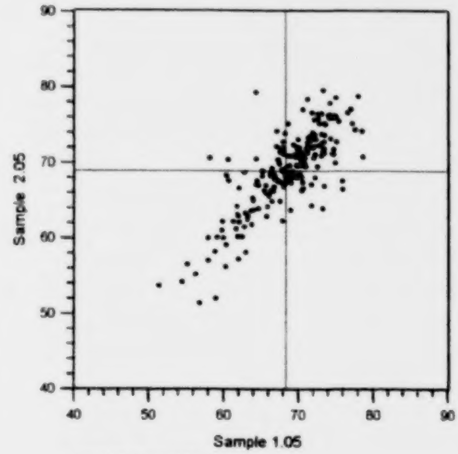


Test 25: Percent Passing the 75 um Sieve

	Mat 1	Mat 2
Mean	7.930	7.630
Median	7.800	7.500
Std Dev	0.460	0.470
n = 203		

Labs Eliminated: 447, 497, 452, 518

Scatter diagram for a test showing random variation with little laboratory bias

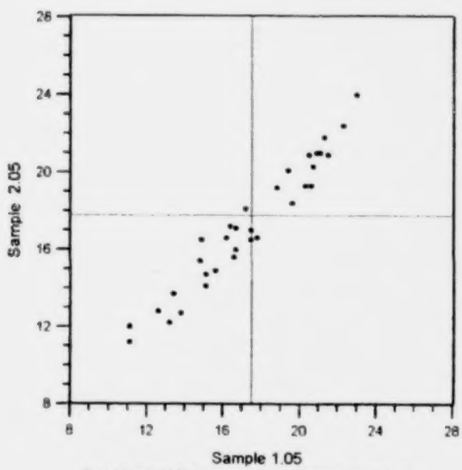


Test 12: Percent Crushed Particles

	Mat 1	Mat 2
Mean	68.491	68.905
Median	68.300	64.500
Std Dev	5.054	5.402
n = 201		

Labs Eliminated: 345, 350, 438, 480

Scatter diagram for a test showing a combination of random variation and laboratory bias for some laboratories

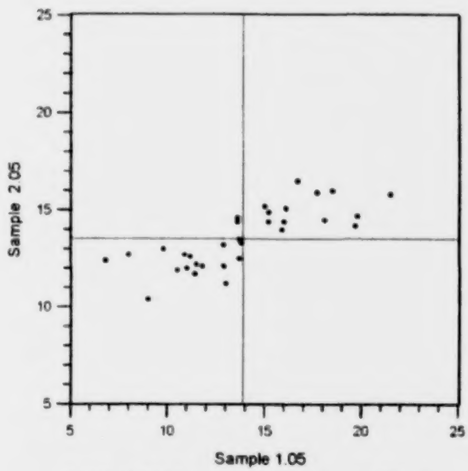


Test 29: MgSO4 Soundness (Fine Aggregate), % Loss

	Mat 1	Mat 2
Mean	17.370	17.258
Median	15.800	15.600
Std Dev	3.276	3.325
n = 32		

Lab Eliminated: None

Scatter diagram for a test showing pronounced between laboratory bias and equal variation for each material



Test 11: MgSO4 Soundness (Coarse Aggregate), % Loss

	Mat 1	Mat 2
Mean	13.890	13.570
Median	12.900	13.600
Std Dev	3.533	1.541
n = 31		

Lab Eliminated: None

Scatter diagram for a test with pronounced between laboratory bias but unequal variation for each material

Figure 1. Examples of Scatter Diagrams

2.3 OUTLIERS

In dealing with suspected outlying observations or 'outliers', our purpose is to remove those observations that do not belong to the sample population and to provide some statistical criteria for doing so. There are a number of ways to do this. In most of these, as ASTM E178 states, 'the doubtful observation is included in the calculation of the numerical criterion (or statistic), which is then compared with a critical value based on the theory of random sampling to determine whether the doubtful observation is to be retained or rejected.' The critical value is that value of the sample criterion that would be exceeded by chance with some specified (small) probability on the assumption that all observations did indeed constitute a random sample from a common system of causes, a single parent population, distribution, or universe.

The MTO study follows the criteria recommended for single samples in Section 4 of ASTM E178 for rejecting the doubtful observations at the ninety-five percent confidence level. The critical value method is based on the assumption of normality, and the critical values are calculated using Student's T distribution. The assumption in this method is that all of the observations come from the same normal population. The doubtful observation is included in the calculation of mean and standard deviation of the population. Then the critical value, T_n, for that observation, n, in question is calculated and compared with the critical value based on the theory of random sampling. The doubtful observation is rejected if T_n is higher than the critical value for the five percent significance level. The outlier is removed from the data set and the iterations are continued until no outliers are detected, and a revised mean and standard deviation are calculated after deleting the outlier. The ratings of the laboratories are determined based on the revised mean, standard deviation, and standardized deviate.

In some cases, the strict application of the critical value method tends to include laboratories in the population that are not doing a good job. In those cases, the application of the iterative technique (Manchester[6]) is used. The Constant C in the iterative technique is computed using Fisher's F distribution, and it depends on the number of participating laboratories in a particular test. In this technique, an outlying observation is rejected based on a statistical criterion, but the confidence interval may vary depending on the number of participants and the distribution of sample population.

In the iterative technique, after screening the test results for any errors, the doubtful test result is included in the calculation of mean and standard deviation of the data set. The absolute residual values (actual test result minus the mean) are then computed and test result farthest from the mean by a unit of Cs (standard deviation, s, multiplied by a constant C) is identified as an outlier. One outlier at a time is identified and rejected in a manner similar to that of critical value method.

6 The Development of an Interlaboratory Testing Program for Construction Aggregates, by L. Manchester, Ministry of Transportation, Ontario, Engineering Materials Office Report EM-33, Downsview, December, 1979.

3. Discussion

The following discussion contains general and test-specific comments for the 2009 test period. Where ASTM or AASHTO precision statements are published for a given test, an attempt has been made to compare these with the statistics for this period.

A discussion of statistical techniques is presented in the Glossary of Terms, found in Appendix A.

3.1 NOTES ON MATERIAL SOURCES

Materials used in this test period were as follows:

- Coarse and fine aggregate tests, including Sieve Analysis, Percent Crushed Particles, Petrographic Analysis (CA), Moisture Density Relationship, Relative Density and Absorption (FA), Micro-Deval Abrasion Loss (FA), Uncompacted Void Content, Sand Equivalent Value, and Percent Fractured Particles – David Pit Granular A from CBM Aggregates (MTO MAIDB No. C44-345).
- Coarse aggregate tests, including Wash Pass 75 µm, Percent Flat and Elongated Particles, Relative Density and Absorption (CA), Los Angeles Abrasion, Micro-Deval Abrasion Loss (CA), Magnesium Sulphate Soundness (CA), Freeze-Thaw, and Percent Flat, Elongated, or Flat and Elongated Particles –from Drain Brothers Stony Lake Quarry (MTO MAIDB No. B09-043).
- Fine Aggregate Petrographic Examination - Scalped sand from the Huron Construction pit (MTO MAIDB Number C08-003) 11.5 km east of Chatham.
- Soil tests – Glacial Lake Iroquois deepwater laminated silt and clay from Walker Brothers Vineland I Quarry, N03-023.

3.2 NOTES ON SAMPLE PREPARATION

The material processed for the coarse aggregate tests conforms approximately to the gradation requirements of Granular A. The aggregate samples were prepared using a large spinning riffler, developed and built by staff at the MTO Downsview Laboratory (refer to Figures 2 and 3 of Report MI-179, February 2000). A bobcat loader was used to fill an aggregate bin with small scoops from the stockpile, and the material was fed along a conveyor belt to fill 30 identical bags (fitted with funnels) on a spinning turntable. It was found that 18 to 24 revolutions of the turntable were required to fill each bucket to 25 ± 2 kg of Granular A. This resulted in more homogeneity of the samples than would normally be the case using other techniques. In total, five hundred 25 ± 2 kg samples were prepared for the tests on Granular A, and randomized for distribution to participating laboratories. The participants were responsible for the preparation of their own fine aggregate samples (3.09 and 4.09) from the two bags of Granular A supplied.

However, the number of revolutions of the turntable required for coarse aggregate to fill each

bucket to approximately 24 ± 2 kg was found to be same as (18 to 22) that of the Granular A. In total, five hundred 24 ± 2 kg samples were prepared for the coarse aggregate tests using HL stone, and randomized for distribution to participating laboratories.

The soil was air-dried, processed passing 2.0 mm using a Fritsch Soil Mill Pulverizer, and placed in 20 kg buckets. Individual scoops were collected from each bucket and placed in a separate container. The material from the container was then transferred to the hopper of a small spinning riffle splitter. The hopper of the spinning riffle used is capable of filling 24 identical 2 kg containers per run. This method was used to create uniform 20 kg buckets. The correlation material was then prepared by obtaining representative samples from a 20 kg bucket. The material collected from the 20 kg bucket was then transferred to the hopper of the spinning riffle and the 500 g correlation samples were prepared. The samples were then randomized for distribution to participating laboratories. The use of a spinning riffler ensured that, as far as possible, each sample was identical to every other sample. It has been found that this is the best technique for minimizing sample bias.

3.3 NOTES ON INDIVIDUAL TESTS

For each test, comments have been made pertaining to the variation illustrated by the scatter diagram. The technique used to test for outliers is stated and, where possible, reasons for the outlying observations are offered. It is important to keep in mind that there are many variables influencing laboratory testing.

A summary of the statistical data is presented in the Multi-Laboratory Precision Tables found in Appendix C. Besides the comparison made to ASTM or MTO precision statements, comparison of the variation between test periods is made for each of the tests. Because the materials usually differ from year to year, it is emphasized that the comparison between years should be used only as a guide. It is important to note that the yearly use of different materials will have some effect on the variation exhibited in some tests, while it will have relatively little effect on others. For example, the magnesium sulphate soundness test normally exhibits increased variation as higher mean loss is reported. A coarse aggregate sample having an average mean loss of twenty percent would likely show more variation than a coarse aggregate sample having an average mean loss of ten percent. On the other hand, a sieve analysis could be performed on those same two aggregates, with the percent passing each sieve and the variation being remarkably similar for the two samples.

3.4 PROFICIENCY SAMPLE TESTS

3.4.1 Wash Pass 75 µm (Coarse Aggregate) – Test No. 1

Two hundred and eighteen laboratories participated in this test in 2009. Four outliers were identified and rejected using the critical value method. The standard deviations obtained in 2009 are consistent with that of the values reported in the 2008 study and the multi-laboratory variation published by ASTM for aggregates with less than 1.5% material finer than 75 µm. However, it should be noted that the mean value of the aggregate used in 2009 consisted of 1.9% material finer 75 µm and is higher than that of ASTM value for which the precision statement was develop. The scatter diagram shows a random variation with little laboratory bias. The laboratories that are identified as outliers or with a zero rating should examine their test procedure more closely, especially the achievement of constant dry mass at the beginning and end of the test.

3.4.2 Sieve Analysis (Coarse Aggregate) – Test Nos. 2 to 6

These tests represent the coarse aggregate portion of the Granular A sample gradation. Tests 20-25 carried out on the material passing 4.75 mm sieve as prepared by the participants (samples 3.09 and 4.09) represent the remainder of the gradation. The data is presented in percent passing format and is compared to precision statements developed in the same format by Vogler and Spellenberg[7].

The Granular A samples supplied for the sieve analysis tests consisted of approximately 27.6% of the material retained on 4.75 mm sieve, and conform to the grading of materials (Granular A) used in the past MTO Aggregate and Soil Proficiency Sample Testing Programs. The gradings reported for Test Nos. 2- 6 represent the combine gradings of coarse and fine aggregates.

The samples were prepared with a large spinning riffler that is described in Section 3.2. This method of preparation minimizes the sample variation and has resulted in almost identical mean values (i.e. percentage of material passing each sieve) for samples 1.09 and 2.09. The variations found in 2009 for the coarse sieves are significantly lower than the values obtained in the past three years. Further, the standard deviations obtained for all of the sieves, are also significantly lower than that of the expected variations given in the ASTM precision statements.

Two hundred and eighteen laboratories performed the sieve analysis test in 2009. Outliers were eliminated using the critical value method. Successive scatter diagrams show a fairly uniform distribution of points about the mean (i.e. a random variation with little laboratory bias). The number of outliers identified varies from sieve to sieve, and it ranges from three for the 16.0 mm sieve to a maximum of ten for 9.5 mm and 4.75 mm sieves.

7 Vogler, R.H., Department of Transportation, Michigan, AASHTO Technical Section 1c; T27 and Spellenberg, P.A., AASHTO Materials Reference Laboratory; Unpublished Paper.

Possible reasons for outlying observations include factors that impact the measurement process such as sieve condition (state of repair and cleanliness), efficiency of the sieving process and apparatus, initial sample mass, and mass on a given sieve. If your laboratory has performed poorly in this test period, you should inspect your sieves (use CAN/CGSB-8.1-88 or ASTM E11 as guides) and your sieve shaker(s) thoroughly, and, once satisfied that they are in order, perform a sieving efficiency test (MTO LS-602) to pinpoint any problems.

3.4.3 Los Angeles Abrasion Loss (Coarse Aggregate) – Test No. 8

Only twelve laboratories participated in this test in 2009. Two outliers were detected by the use of critical value method. Considering the number of observations (12) used, the analysis may not yield a meaningful or representative statistical data. The lower left and upper right quadrants together account for all of the twelve points, which is evidence of significant laboratory biases. This test shows systematic variation, as was found in previous years. However, the variations in 2009 are slightly higher than the values found in the past studies, and the coefficient of variation published in the ASTM precision statement.

ASTM precision statements for 19.0 mm maximum size coarse aggregate, with percent loss in the range 10% to 45%, give a multi-laboratory coefficient of variation of 4.5%. Therefore, results from two different laboratories should not differ by more than 12.7%. The mean in this test (26.0%) is in the range of values for which ASTM data was established. This year's coefficient of variation (average 5.9%) is slightly higher than that of the value, 4.5%, given in the ASTM precision statements.

3.4.4 Relative Density (Coarse Aggregate) – Test No. 9 and Absorption (Coarse Aggregate) – Test No. 10

One hundred and six laboratories participated in these tests in 2009. Nine laboratories in Test No. 9 and eleven laboratories in Test No. 10 were eliminated using the iterative technique. The standard deviations obtained for bulk relative density (Test No. 9) are consistent with the values that were reported in the past three years, and are considerably less than that of the value given in the ASTM precision statements. A similar trend was observed in the absorption test (Test No. 10). The variations obtained in 2009 are noticeably less than that of the values reported in past three years studies and the precision estimate provided in ASTM C 127 - 88. The latest version of ASTM C127-07 does not provide precision estimate for the absorption test. The expected variation shown on the precision table in Appendix C is based on the previous publication C127-88. The scatter diagrams for both of these tests show a random variation with laboratory bias for some laboratories.

3.4.5 Magnesium Sulphate Soundness (Coarse Aggregate) – Test No. 11

Forty-one laboratories reported results for this test in 2009. Two outliers were identified by the use of iterative technique. The scatter diagram shows a strong laboratory bias and all the points, with the exception of eight (80%), are accounted in the lower left and upper right quadrants. This test has historically shown high coefficients of variation due to the difficulty of maintaining solution of the correct density and insufficient drying by some laboratories.

The coefficient of variations obtained in 2009 (25.7%) is noticeably less than the values (28.6% to 32.9%) obtained in the past three years. The mean in this test (8.9%) is in the range of values for which ASTM precision estimate was established and the variations obtained in 2009 are consistent with that of the value published in the ASTM precision statements. ASTM reports a multi-laboratory coefficient of variation of 25% for coarse aggregate with percent loss in the range of 9% to 20%.

3.4.6 Percent Crushed Particles – Test No. 12 and Percent Cemented Particles – Test No. 7

Two hundred and eighteen laboratories performed the percent crushed particles test in 2009. Three outliers were selected by employing the critical value method. The standard deviation obtained (7.0%) in 2009 is slightly higher than the values (3.7% to 6.40%) reported in the past three years and the value (6.0%) obtained during the 1989 MTO workshop. The mean in this test (57.0%) is within the range of values (50% to 75%) for which the MTO precision statement was established. The scatter diagram shows a random variation and operator bias for some laboratories. The samples distributed did not contain any cemented particles; therefore the percent cemented particles test was not evaluated this year. ASTM has a very similar test method (D 5821) but has not conducted interlaboratory studies to determine precision and currently publishes precision data (standard deviation of 5.2% for a mean value of 76.0%) obtained from MTO study.

3.4.7 Percent Flat and Elongated Particles – Test No. 13

The determination of a flat and/or elongated particle is dependent on operator skill and judgement in using the measurement tool. The ASTM and CSA procedures use a proportional calliper device to measure the *greatest* length or width to thickness ratio. The MTO procedure previously measured the ratio of *mean* length or width to the *mean* thickness (MTO Laboratory Manual Revision 15 and earlier). The MTO procedure (Revision 16 and up) has been modified to agree with the ASTM definition. All participants should be using the latest MTO version of the test.

Two hundred and seven laboratories reported results for this test in 2009. The iterative technique was used to reject thirteen outliers. ASTM and CSA do not report precision for this test method. MTO Test Method LS-608 provides estimates of precision for coarse aggregate passing 19.0 mm and retained on 4.75 mm. The coefficient of variation, 41.5%, obtained in 2009, is noticeably less than that of the values reported in 2008 (50.0%), and consistent with the precision estimate (41%) published by MTO.

The scatter diagram provided in the Appendix D1 shows a combination of random variation and laboratory operator bias for some laboratories. In general, laboratories that reported values in excess of 10% and below 1% should critically examine their equipment and procedure.

3.4.8 Petrographic Number (Concrete) – Test No. 14

The coarse aggregate examined in 2009 was Granular A from the David Pit owned by CBM Aggregates (MTO MAIDB No. C44 - 345).

Thirty two sets of worksheets were submitted from 27 laboratories. Labs 188 and 79 submitted results from multiple analysts for one set of sample bags. In these cases, only the results of one analyst from each lab was accepted and considered representative for a single set of sample bags that were supplied. In total, 27 worksheets from 27 labs were considered as part of the 2009 proficiency program. In the future, if more than one analyst from a single lab wishes to participate in the MTO proficiency sample testing program, a lab number needs to be assigned to each petrographic analyst and additional sets of samples must be requested. A reduced fee will be charged for the additional sets of samples supplied for this test. Labs 13, 15 and 59 used the same analyst as did labs 80 and 101.

The samples contained approximately 90-95% good aggregate (approximately 80-85% good carbonate rock types 1, 20, 2 and 21; and 5-10% silicate rock). The range in good carbonate content reported by labs during this test period was 32.1% to 92.6% indicating a need for some labs to do better with their carbonate classifications. Lab 295 reported 47.4% and 32.1% good carbonate aggregate content for samples 1.09A and 2.09A, respectively. Lab 295 also identified hard to medium hard conglomerate-sandstone-arkose (rock types 3 and 22) as composing 40.7% of sample 1.09A and 55% of sample 2.09A. Average combined amounts of rock types 3 and 22 present in the material was generally 3-4%. Higher than average combined silicate rock contents were reported by labs 23, 260, 295 and 316. Lab 23 somewhat overestimated the average greywacke-argillite (rock type 6) content with 13% and 15.2% for samples 1.09A and 2.09A, respectively. The average for rock type 6 was 1.1 to 1.2%.

The samples contained approximately 6% fair aggregate (mainly soft carbonate to silty soft carbonate; encrustation; and chert-cherty carbonate). Labs 295 and 79 reported higher than average amounts of fair aggregate with 20% for sample 1.09A (Lab 295) and 16.2% for sample 2.09A (Lab 79). Lab 295 underestimated the amount of fair aggregate in both samples as less than 2%. Several labs correctly identified the presence of encrustation (rock type 52). However, the observed amounts of encrustation varied where present from 0.1% to 4.2%. An examination of a set of samples suggests that this amount may be higher. This range possibly reflects the subjectivity of the test and preparation method of test samples as well as variability of source material.

Poor aggregate content averaged 2% to 2.5% (mainly cementations and poor carbonates) and ranged from 0 to 9.6%. All but 6 labs noted the presence of cementations (rock types 53 and 54). Amounts of cementations recorded ranges from 0.1 to 7.6%. This variation is likely due to a combination of test sample preparation, source variability and subjectivity of the test. Sample preparation and soaking has the potential to disaggregate or loosen the cemented particles prior to examination.

There is a need for labs 79, 260, 295, and 296 to modify their rock quality classification system. Lab 295 failed to correctly identify several of the major components present in the

aggregate samples. Therefore, it was manually removed from the analysis and identified as an outlier. This lab underestimated good carbonate content by 33 to 53% and overestimated the good silicate content by 39 to 56% as compared to the average for these rock types. Two outliers (Labs 79 and 296) were selected by employing the critical value method. Labs 296 and 79 underestimated the good aggregate content by 16 to 22% and 10 to 21%, respectively as compared to the average for these rock types. The fair aggregate content was overestimated by 11 to 14% (Lab 296) and 8 to 10% (Lab 79). The overestimation of the fair aggregate content was reflected in the high petrographic numbers reported by these two labs (see the scatter diagram in Appendix D1).

The similar ASTM standard for this test, C295, does not report a petrographic number and has no precision statement.

3.4.9 Petrographic Analysis (Fine Aggregate)

The fine aggregate examined in 2009 was sand from the Huron Construction Pit (MTO MAIDB No. C08-003).

Ten worksheets were submitted from 8 laboratories. Lab 188 submitted results from 3 analysts for one set of sample bags. In this case only the results from one analyst was accepted and considered representative for a single set of sample bags that were supplied. In total, 8 worksheets from 8 labs were accepted as part of the 2009 proficiency program. In the future, if more than one analyst from a single lab wishes to participate in the MTO proficiency sample testing program, a lab number needs to be assigned to each petrographic analyst and additional sets of samples must be requested. A reduced fee will be charged for the additional sets of samples supplied for this test. Labs 15 and 59 used the same analyst as did Labs 80 and 101. Lab 27 gave a more detailed breakdown of the rock and mineral types present than what is listed on form PH-CC-437. It was necessary to group these into the categories on form PH-CC-437 so that the results from this lab could be compared with other laboratories.

Laboratories 15, 27, 47, 59, 80, 101, and 188 submitted incomplete worksheet and failed to report some of the information required by the test method. The information missing from some of these labs are an estimate of percent crushed particles for the individual sieve fractions, weighted average percent chert, and percent of material retained on each sieve. The gradation test results of Labs 80, 101, and 188 indicate that the sum of the material retained on individual sieves totalling to 100 percent. This suggests that these laboratories have not taken into account the material finer than 75 μm present in the samples. As required by Section 7.3 of the test method, the percent finer than 75 μm should be included in the calculations of weighted percent chert.

The samples contained an average (unweighted) of approximately 47% silicate rocks and minerals, 42.5% carbonate rocks and minerals, 6.5% shale, 0.5% mica, and 3% to 3.5% chert. Silicate contents increased from larger to smaller sieve sizes; and carbonate and chert contents generally decreased. All laboratories performed well in correctly identifying the rock and mineral components contained in the samples. Labs 27 reported slightly higher silicate contents and slightly lower carbonate contents as compared with other labs. The

average of the reported silicate contents for lab 27 was 9-10% greater than the average values for all labs. The average carbonate contents reported by Lab 27 for Sample 1.09 was also 6 to 7% lower than that of the average values reported by other laboratories for carbonate contents.

Lab 59 reported 5 and 8% mica in the 300-600um and 150-75µm portions, respectively for Sample 1.09A. This was slightly higher than that reported by other labs.

The similar ASTM standard for this test, C295, has no precision statement.

3.4.10 Micro-Deval Abrasion (Coarse Aggregate) – Test No. 16

Seventy laboratories reported results for this test in 2009. The test method requires reporting of control sample results to demonstrate that the testing process is in control. This year, one laboratory reported control sample results outside the established range and the lab was excluded from the analysis. Three outliers were rejected using the iterative technique.

The multi-laboratory coefficient of variation of 5.6% published in the latest revision is for 19.0 mm maximum size aggregate with abrasion losses in the range from 5% to 20%. The mean loss in this year test was 13.1%. The average coefficient of variation of 7.7% obtained in 2009 is slightly higher than the value published in LS-618, and that of the values reported in the past three years (5.5% to 6.5%). The scatter plot for this test shows a combination of random variation and laboratory bias for some laboratories.

3.4.11 Freeze-Thaw Loss – Test No. 17

Fifty-five laboratories reported results for this test in 2009. The test method requires reporting of laboratory control sample losses to demonstrate that the testing process is in control. This information is used to alert the laboratory to testing deficiencies. Without testing of the reference material, the test is invalid (see MTO Test Method LS-614, Section 9.1). This year, one laboratory reported control sample results outside the established range. Three outliers were selected using the iterative technique.

The multi-laboratory coefficient of variation of 21% published in the MTO LS-614 is for coarse aggregate with freeze-thaw losses in the range of 5% to 18%. The coefficient of variation obtained in 2009 (16.9%) is significantly less than the value, 21%, published in the MTO precision statements, and the values reported in the 2007 (20.8%) and 2008 (21.3%) studies. All of the points on the scatter plot (85.5%), with the exception of eight, are accounted in the lower left and upper right quadrant, indicating a strong laboratory bias.

The results reported by the three outlier laboratories deviate considerably from the mean values. It is likely that there are two main reasons for the wide spread of their data: insufficient damage caused by freezing, which may be due to freezing too rapidly, or difference in sieving intensity. The laboratories identified as outliers should modify their processes to try and achieve losses closer to the mean loss of the control aggregate. Test Method LS-614 (Appendix 1) in the MTO Laboratory Testing Manual gives a procedure for determining and adjusting sieving time for quantitative analysis.

3.4.12 Sieve Analysis (Fine Aggregate) – Test Nos. 20-25

The samples for this procedure were prepared by the participants from the material passing the 4.75 mm sieve of the coarse aggregate gradation. This process closely follows the normal testing procedure in which the laboratory prepares its own test samples from the field sample. The scatter diagrams for the fine aggregate sieve analysis show random variation with little laboratory bias. The standard deviations of the fine sieves, with the exception of 300 μm and 600 μm sieves, in 2009 are consistent with that of the values reported in 2008 study. However, the multi-laboratory variations are noticeably higher than that of the values published in the ASTM C136 precision statements.

As in previous interlaboratory studies, it was found that the precision of the test varies as a function of the amount of material retained on any sieve. The smaller the amount of material retained on the sieve, the more efficient the sieving process and the better the precision. When there is a small amount of material on a sieve (one layer of particles or less), the particles have a greater chance of falling through the sieve in a given time.

The number of outliers identified varies from sieve to sieve, and it ranges from nine for 150 μm sieve to a maximum of sixteen for the 2.36 mm sieve. Outlier labs with a very low percent passing the 75 μm sieve should inspect their sieves, as low percent passing may be the result of the sieve being blinded when washing the sample. An ineffective washing process will also result in a low percent passing the sieve.

3.4.13 Relative Density (Fine Aggregate) – Test No. 27 and Absorption (Fine Aggregate) – Test No. 28

Participants in the 2009 program were asked to test both samples 1.09 and 2.09 according to MTO Test Method LS-605. This test method follows ASTM C128, except that it requires the removal of materials finer than 75 μm from the test specimen. The significant difference between the methods is that MTO LS-605 requires the test specimens to be prepared in duplicates and washed on the 75 μm sieve until all of the material finer than 75 μm is removed. The presence of material finer than 75 μm in the test specimens can result in lower densities and higher absorption.

One hundred and two laboratories reported results for these tests. Fourteen outliers for Test No. 27 and five outliers for Test No. 28 were selected using the iterative technique. As in previous years, greater variation exists in this test compared to the relative density test on coarse aggregate. It is imperative that differential drying of the various sized particles be avoided by *constant* stirring of the sample under the air current during the drying process. As short as 30-second periods of rest can be detrimental to the outcome of the test results. Differential drying of the particles is known to cause premature collapse in the cone test used to judge the saturated surface dry state. The resulting test observations are lower relative densities and higher absorption values.
The standard deviations obtained in 2009 for both relative density and absorption is consistent with the values that were reported in the 2008 study. In addition, the multi-laboratory variations obtained in 2009 are significantly lower than that of the values published in the ASTM precision statements. The scatter plots for both tests show a

combination of random variation and laboratory bias for some laboratories.

3.4.14 Amount of Asphalt Coated Particles in Coarse Aggregate – Test No. 30

Two hundred and seventeen laboratories reported results in 2009. Fourteen laboratories were identified as outliers using the iterative technique. The scatter plot shows a combination of random variation and laboratory bias for some laboratories. The MTO Test Method LS-621 provides precision estimate for 19.0 mm maximum size coarse aggregate mixed with asphalt coated particles in the range of 25% to 45%. The coefficient of variation obtained in 2009 (15.6%) is consistent with the value reported in 2007 (16%) and 2008 (16.2%), but significantly higher than that of the precision estimate (9.6%) published in the MTO LS-621. Laboratories that reported values of less than about 19% and above 36% should critically evaluate their interpretation of the definition and re-examine their samples. There is no comparable or similar ASTM test procedure.

3.4.15 Moisture-Density Relationship (One-Point Method) – Test Nos. 31-33

The finer portion of the Granular A (i.e. material passing the 4.75 mm sieve) was used for this test. The samples for this test procedure were prepared by the participants from the bulk Granular A samples supplied.

One hundred and fifty-eight laboratories reported results for this test in 2009. Eight outliers for Test Nos. 31 and five outliers for Test No. 33 were rejected using the critical value method. The standard deviations obtained in 2009 for all three tests, i.e. wet density (Test No. 31), dry density (Test No. 32), and optimum moisture content (Test No. 33), are consistent with the values reported in 2008 and the precision estimates published in MTO LS-623.

The majority of the points in the scatter diagrams are accounted in the lower left and upper right quadrant of the plots, indicating strong laboratory bias. The possible causes for the strong laboratory bias may be operator error and the use of an improper mould, even though the participants were requested to use only the 152.4 mm diameter mould. This test also requires significant operator skill to obtain the point within the band in the first attempt. Those laboratories with poor ratings should examine their equipment and procedure to discover the causes for this variation. There is no ASTM precision statement for this test.

3.4.16 Micro-Deval Abrasion (Fine Aggregate) – Test No. 34

Participants in this test were asked to prepare their own sample from the bags of bulk Granular A supplied. Seventy laboratories participated in this test in 2009. The test method requires reporting of control sample test results to demonstrate that the testing process is in control. This year, all of the laboratories, except one, reported control sample results within the range established for the material. This lab was manually removed from the statistical analysis.

MTO Test Method LS-619 provides precision estimates for fine aggregates with the abrasion

loss in the range of 7% to 30%. The coefficients of variations of 8.7% obtained in 2009 is consistent with the precision estimate (8.7%) published in MTO LS-619. However, the coefficient of variation obtained is slightly higher than the values (5.7% to 7.4%) reported in the past three years.

One outlier was selected by the use of critical value method. Majority of the data points are located in the lower left and upper right quadrant of the scatter diagram indicating a strong laboratory bias.

3.4.17 Particle Size Analysis of Soil – Test Nos. 40-45

The ministry has been using the MTO Test Method LS-702 since 2000 for its annual testing program. Based on the data sheets submitted by the laboratories, all of the laboratories performed the test in accordance with MTO LS-702. Seventy-one laboratories participated in the hydrometer test in 2009. Test No. 40 is reported for information purposes only, because 92% of the participants reported 100% passing 2.00 mm sieve. Outliers were selected using the iterative technique.

Successive scatter diagrams for this test show significant laboratory biases. The standard deviations obtained in 2009 are consistent with the results reported in the past three years. The laboratories that are identified as outliers should examine their equipment and procedure very carefully to ensure that all is within specification and the procedure is followed exactly.

3.4.18 Atterberg Limits of Soil – Test Nos. 46-48

Eighty-five laboratories reported results for Atterberg limit tests in 2009. Six outlier laboratories for liquid limit (Test No. 46) and four for plastic limit test (Test No. 47) were identified using the iterative technique. The scatter plots for both liquid and plastic limit tests as well as for plasticity index (Test No. 48) show strong laboratory bias. Both liquid and plastic limit tests require significant operator skills. Liquid limit test also requires good condition and calibration of the apparatus. The variations observed are characteristics of these two tests. Close attention to the condition and calibration of the liquid limit apparatus and employing skilled technicians may reduce the laboratory biases.

The variations obtained for liquid and plastic limit tests in 2009 are consistent with those of the values reported in the past three years. Further, the standard deviations obtained for plastic limit and plasticity index are consistent with the values published in the ASTM precision statements. However, the standard deviations obtained for liquid limit test are almost twice that of the precision estimate published in ASTM D 4318.

3.4.19 Specific Gravity of Soils – Test No. 49

The participants were requested to perform this test according to MTO Test Method LS-705. This test method requires that the test be performed on a minimum of three specimens, and the range (the difference between the largest and smallest value of the test specimens) of the specific gravity of all three specimens determined shall be within 0.02. The test must be

repeated if the range exceeds the specified limit. The laboratories that report results with the range in excess of 0.02 indicate that these labs are not capable of repeating the test within their testing environment. These laboratories are manually deleted from the analysis and identified as outliers. This year, five laboratories were removed for exceeding the specified limit of 0.02.

Sixty laboratories reported results for this test in 2009. One outlier was identified using the iterative technique. Ninety percent of the plots are located in 1st and 3rd quadrants of the scatter diagram showing a strong laboratory bias. Several steps in this test procedure can influence the results, particularly the equipment and method employed for preparation of test specimen, as well as for removal of air entrapped in the pycnometer or flask. The possible cause for the bias may be because the laboratories do not fully comply with the test procedures. Laboratories finding themselves in this situation should examine their equipment and procedure very carefully.

The standard deviations obtained in 2009 are consistent with the results reported in the past three years. MTO LS-705 is similar to that of AASHTO T 100, which reports a multi-laboratory standard deviation of 0.04. As in the past three studies, the standard deviations obtained in 2009 are also significantly lower than that of the precision estimate published in the AASHTO T 100.

3.5 SUPERPAVE CONSENSUS PROPERTY TESTS

3.5.1 Uncompacted Void Content (FA) – Test No. 95

The participants were asked to perform the test in accordance with MTO Test Method LS-629, using the fine aggregate prepared by splitting the material passing 4.75 mm sieve. This test method is a modified version of AASHTO T 304. MTO LS-629 follows Method A of AASHTO T 304, except for the preparation of the test specimen to be used in the determination of bulk specific gravity of fine aggregates. The significant difference between the methods is that MTO LS-629 requires the test specimens be washed on the 75 μm sieve until all the material finer than 75 μm is removed. In addition, MTO LS-629 specifies that the bulk relative density is determined using the graded sample and not the individual size fraction method described in Clause 9.4 of AASHTO T 304. Further, the participants were advised to compute the uncompacted void contents of Samples 1.09 and 2.09 using the bulk relative densities reported for Test No. 27 (i.e. the densities determined according to MTO LS-605).

Sixty-three laboratories submitted results for this test in 2009. Four laboratories were identified as outliers using the iterative technique. The scatter diagram shows a combination of random variation and laboratory bias for some laboratories. The standard deviations obtained in 2009 (0.68 and 0.56) are consistent with the values obtained in 2007 and 2008. The standard deviations obtained for both samples are noticeably higher than the value (0.33%) published in the ASTM precision statements for graded standard sand. The estimates of precision in ASTM are based on graded sand as described in ASTM C778, which is considered rounded, and is graded from 600 μm to 150 μm, and may not be typical

of the samples that were used in this testing program.

ASTM C1252 suggests that a difference in relative density of 0.05 will change the calculated void content by about one percent. There is marked improvement in the multi-laboratory variation since 2008. The improvement may have resulted from the changes made to MTO Test Method LS-605 in 2006. The laboratories that are identified as outliers must review their test procedures and the skill of the technician.

It should be noted that adopting the revised procedure where the fine aggregate is washed before determining density will usually give a higher bulk relative density. This, in turn, will result in higher uncompacted void contents for fine aggregates with significant minus 75 µm fines contents. The impact on fine aggregates with low fines contents will be small since density will not normally change significantly.

3.5.2 Sand Equivalent Value of Fine Aggregate – Test No. 96

The participants were asked to prepare the fine aggregate sample for this test by splitting the material passing 4.75 mm sieve. Two alternate procedures for the preparation of test specimen (air-dry or pre-wet) are allowed in both ASTM and AASHTO methods. The participants were given the option of preparing the test specimen in accordance with either method.

Fifty-nine laboratories participated in this test in 2009. One outlier was identified by the use of critical value method. The lower left and upper right quadrants of the scatter diagram together account for 90% of the points showing significant laboratory bias. The standard deviations obtained in 2009 (5.12 and 5.33) are considerably higher than the values reported in 2007 and 2008, but the values are significantly lower than the multi-laboratory precision value (8.0) published by ASTM for samples with sand equivalent value less than 80.

3.5.3 Percent of Fractured Particles in Coarse Aggregate – Test No. 97

The samples supplied did not contain adequate material retained on 19.0 mm sieve. Because of this, the participants were advised to perform the test on coarse aggregate passing the 19.0 mm sieve only.

Sixty-four laboratories submitted results for this test in 2009. Three outliers were detected using the iterative technique. The scatter diagram shows a strong laboratory bias. The average mean values obtained by the ASTM method (58.5%) and MTO versions (57.0%) of the test on the same aggregate differ by only 1.5%, and the standard deviations obtained by ASTM (6.8%) is almost identical to that of MTO version (7.0%). The ASTM test method is very similar to MTO Test Method LS-607, but ASTM has not conducted interlaboratory studies to determine precision and currently publishes statistical data provided by MTO. The variations obtained in 2009 (6.8%) is significantly higher than the values obtained in the past three years, and are noticeably higher than that of the value (5.2%) published in ASTM precision statements.

3.5.4 Percent Flat and Elongated Particles in Coarse Aggregate – Test No. 99

The samples supplied did not contain adequate material retained on 19.0 mm sieve. As a result, the participants were advised to perform the test on coarse aggregate passing the 19.0 mm sieve only, using a ratio of 5:1.

Sixty-six laboratories performed this test in 2009. Six outliers were detected using the iterative technique. The standard deviations obtained in 2009 are significantly higher than that of the values reported in 2008 study. However, the average coefficient of variation of 58.7% obtained in 2009 is slightly lower than the value of 63.5% obtained in 2008. There is no ASTM precision statement for this test.

4. Laboratory Rating System

The laboratory rating system assigns separate ratings for low complexity (production) aggregate laboratories, high complexity (full service) aggregate laboratories, soil, and for Superpave laboratories. Starting 2010, CCIL Type C certification will require participation in the percent flat and elongated particles test. In view of this, low complexity (Type C) laboratories are now required to carry out wash pass 75 µm, sieve analysis, percent crushed particles, percent asphalt coated particles, and percent flat and elongated particles, which was optional in the past. In addition to those low complexity tests, high complexity laboratories must carry out micro-Deval (coarse and fine), freeze-thaw, and/or magnesium sulphate soundness, relative density and absorption (coarse and fine). Soil laboratories are required to carry out particle size analysis, Atterberg limits, and specific gravity of soil.

A similar laboratory rating system is also used for assigning laboratory ratings for Superpave aggregate laboratories. The laboratories are required to perform all four consensus property tests (i.e. uncompacted void content of fine aggregate, sand equivalent value of fine aggregate, percent fractured particles in coarse aggregate, and flat and elongated particles in coarse aggregate).

The rating system gives a maximum of 10 for each test, (e.g. 5 for wash pass 75 µm on sample 1.09, plus -5 for wash pass 75 µm on sample 2.09, equals 10 (the negative sign indicating a test result less than the mean is ignored). See Section 2.1 for explanation of test method ratings. Some tests that are normally reported together are averaged and given a maximum of 10. The relative density and absorption (coarse and fine), one-point Proctor values (maximum wet and dry density, and optimum moisture content), particle size analysis of soils, and Atterberg limits are treated in this manner. Because of the large number of individual test ratings in the gradation results, the ratings are modified so as not to unduly bias the overall balance between various tests. The ratings for each sieve size are added and then divided by eleven coarse and fine sieves for which results were reported, and multiplied by 3 to give a laboratory rating with a maximum of 30 for this test. Individual laboratory ratings are calculated by adding the ratings of each test in the appropriate lab category (i.e. Production, Full Service, Soil, or Superpave) and converting the sum to a percentage of the maximum available rating for the category. The spread of laboratory ratings for production, full service, soil, and Superpave laboratories are given in the form of histograms in Figures 2 to 5. The laboratory rating system data is reported in the Appendices E1, E2, E3, and E4.

Laboratory ratings are given in the covering letter accompanying this report to individual laboratories. A poor or good rating for a laboratory in one year is an indication of how that laboratory performed in the proficiency study, and may not be a reflection of how the laboratory performs year round. A consistently poor rating over two or more years may be cause for serious concern.

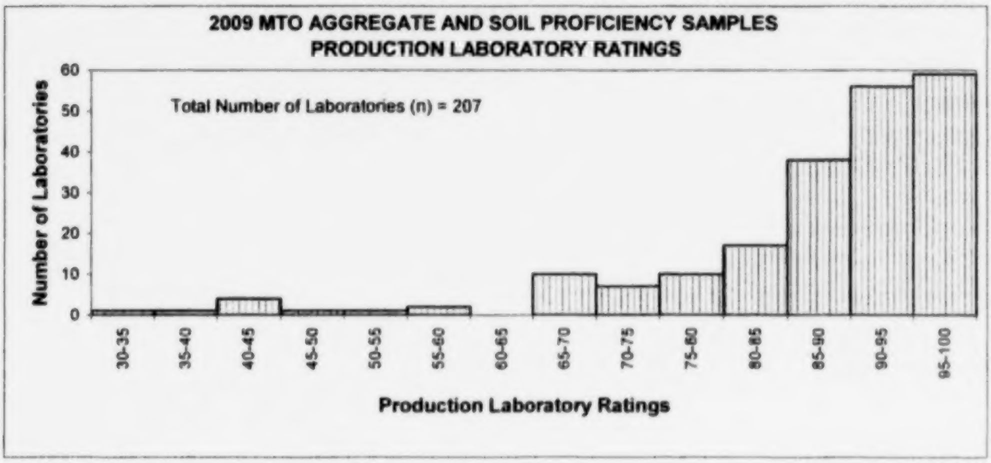


Figure 2. Production Laboratory Ratings

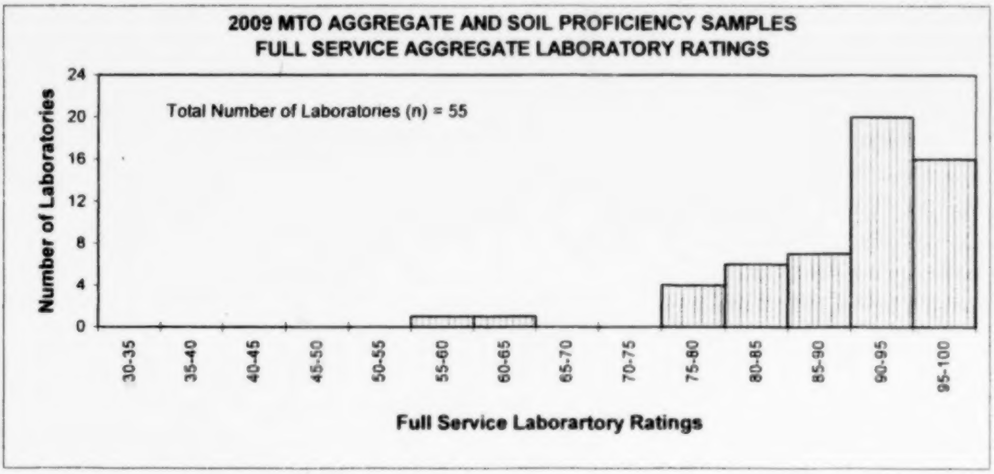


Figure 3. Full Service Laboratory Ratings

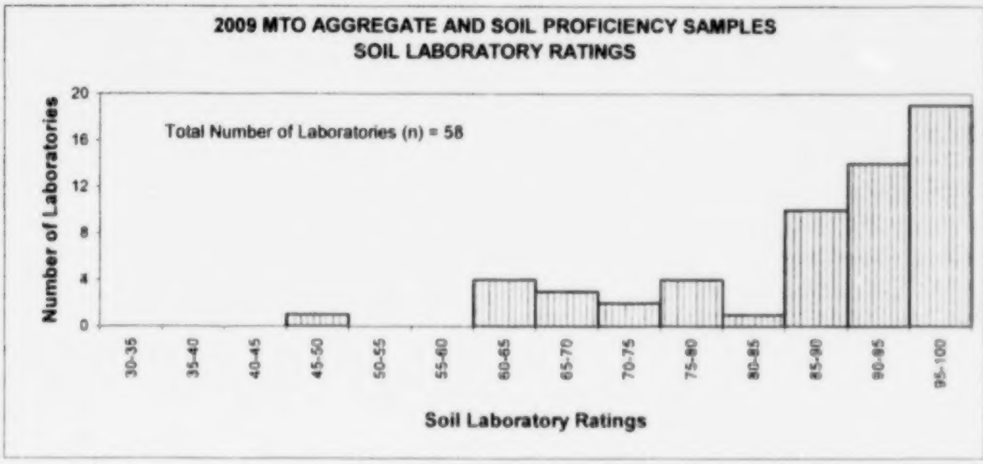


Figure 4. Soil Laboratory Ratings

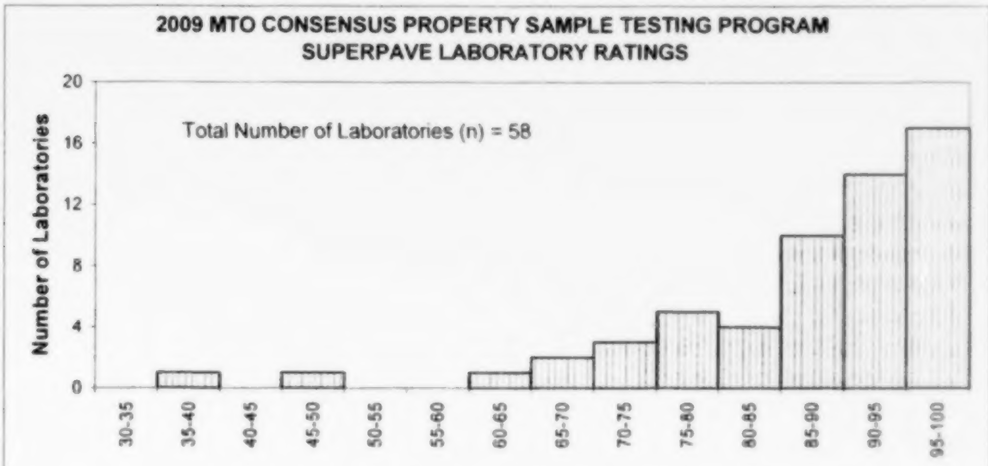


Figure 5. Superpave Laboratory Ratings

5. Conclusions

The method of proficiency sample preparation employed by MTO resulted in almost identical mean gradation values for samples1.09 and 2.09. The differences in mean, as well as in the standard deviations between pairs of samples for both coarse and fine sieves are none to negligible. Based on the results, it may be concluded that the sample preparation method employed is very effective and capable of producing a uniform and nearly identical material at reasonable cost.

The majority of the aggregate and soil test results of the 2009 Aggregate and Soil Proficiency Sample Testing Program compare favourably with the results of previous studies. In some cases, the variations show noticeable improvement over previous years' results and the precision estimates of those tests where MTO or ASTM precision statements are available. The scatter diagrams for the majority of the aggregate tests show either random variation or a combination of random variation and laboratory bias for some laboratories.

Two hundred and thirteen of the laboratories that participated in the aggregate tests are CCIL Type C (Production) certified, and fifty-two of those are Type D certified (Full Service). However, fifty-five laboratories participated in the high complexity (full service) aggregate tests. CCIL inspects the certified laboratories for quality control procedures, ability of technicians, and condition and calibration of the equipment at about eighteen month intervals. Most of the aggregate tests (Type C and Type D) are showing general improvement in variation due to the on-site laboratory inspection by CCIL at regular intervals, proficiency sample testing, and due to an increased awareness of the importance of proper testing and quality control procedures implemented by CCIL.

Fifty-eight laboratories participated in all three soil tests. The variations found in 2009 for the soil tests are consistent with the values reported in the last three years' studies, but the scatter diagrams still show strong laboratory biases. The results of soil tests are significantly influenced by operator skills, testing environment, and the condition and calibration of the equipment. Thirty-three of the fifty-eight laboratories that participated in the soil tests in 2009 are on the MTO Vendors List. The laboratories that are on the list were inspected by MTO staff prior to approval. Most of the laboratories approved were inspected about five to six years ago on a voluntary basis and few re-inspections[8] have been done to date.

Fifty-eight laboratories participated in all four Superpave consensus property tests. The consensus property test results of 2009, with the exception of uncompacted void content, do not compare favourably with the results of previous studies. Further, the multi-laboratory precisions obtained in 2009, except sand equivalent value, are noticeably higher than the values published in ASTM precision statements. As in the past, the scatter diagrams show strong laboratory biases. It is expected that the lab inspection process and the quality control program implemented by CCIL will bring about improvements in multi-laboratory variation.

8 To arrange an inspection of your Soil Laboratory, please contact Mark Vasavithasan, Soils and Aggregates Section, Ministry of Transportation, phone (416) 235-4901, fax (416) 235-4101, Mark.Vasavithasan@ontario.ca.

6. Recommendations

Although, there are noticeable improvements in the multi-laboratory variations, strong laboratory biases still remain in a number of test procedures. The laboratories that were identified as outliers and obtained zero ratings should examine the condition and calibration of equipment, testing procedures, and skills of the technicians. It is good practice to do this whenever a rating of 2 or less is obtained for each sample in a test.

The results of the 2009 MTO Aggregate and Soil Proficiency Sample Testing Program suggest that most laboratories have performed satisfactorily. Laboratories that obtained relatively low ratings must focus on operator training, standardization and calibration of equipment, and improvements to laboratory environment in order to improve their performance.

For all of the tests that were included in this study, the equipment to be used is regulated by the test method itself. A good state of maintenance, repair, and correct calibration may be sometimes lacking. It is hoped that the mandatory Quality System implemented by CCIL will encourage laboratories to conduct a review of their quality system to ensure that they have the correct equipment and properly trained technicians. Laboratories will find that a well-documented and regular program of internal inspection, calibration, and testing of control or reference samples is beneficial to maintaining a high level of confidence in their results.

7. Acknowledgments

The authors wish to acknowledge the assistance and dedicated work of the laboratory staff of the Soils and Aggregates Section in the preparation of samples and performing the tests. We received considerable assistance from the laboratory staff of the Bituminous Section and the Concrete Section in the preparation of correlation samples for distribution.

References

1. American Society for Testing and Materials. Annual Book of ASTM Standards, Vol. 04.02, Concrete and Aggregate.

2. American Society for Testing and Materials. Annual Book of ASTM Standards, Vol. 14.02, Statistical Methods.

3. Grubbs, F.E. and Beck, G., "Extension of Sample Sizes and Percentage Points for Significance Tests of Outlying Observations", Technometrics, TCMTA, Vol. 14, No. 4, November 1972, pp. 847–854.

4. Grubbs, F.E., "Procedures for Detecting Outlying Observations in Samples", Technometrics, TCMTA, Vol. 11, No. 4, February 1969, pp. 1–21.

5. Manchester, L., 1979, "The Development of an Interlaboratory Testing Program for Construction Aggregates", Engineering Materials Office Report EM-33, Ministry of Transportation, Ontario.

6. Vasavithasan, M. and Rutter, B., 2004, "User's Manual for Soils and Aggregates Sample Testing (SASTP) Computer Program", Materials Engineering and Research Office Report MERO-013, Ministry of Transportation, Ontario.

7. Vogler, R.H. and Spellenberg, P.A., "AASHTO T 27 – Sieve Analysis of Fine and Coarse Aggregate", AASHTO Technical Section 1c, Unpublished Paper.

Appendix A: Glossary of Terms

Precision refers to the degree of mutual agreement between individual measurements on the same material. In other words, precision is a measure of how well the individual test results of a series agree with each other.

Accuracy refers to the degree of mutual agreement between a set of measurements with an accepted reference or 'true value'. This 'true' or reference value can be an assigned value arrived at by actual experiments.

Bias of a measurement process is a consistent and systematic difference between a set of test results derived from using the process and an accepted reference value of the property being measured. For the majority of aggregate and soil tests, there is no acceptable reference material, so bias is impossible to compute.

Critical Value is that value of the sample criterion which would be exceeded by chance with some specified probability (significance level) on the assumption that all the observations did indeed constitute a random sample from a common system of causes.

Coefficient of Variation expresses the standard deviation as a percentage of the mean, where:

$$C.V. = \frac{\text{std dev}}{\text{mean}} \times 100$$

Single operator precision (one-sigma limit (1s)) indicates the variability, as measured by the deviations above and below the average, of a large group of individual test results when the tests have been made on the same material by a single operator using the same apparatus in the same laboratory over a relatively short time.

Multi-laboratory precision is a quantitative estimate of the variability of a large group of individual test results when each test has been made in a different laboratory and every effort has been made to make test portions of the material as nearly identical as possible. Under normal circumstances, the estimates of the one-sigma limit (1s) for multi-laboratory precision are usually larger than those for single-operator precision because different operators and different equipment are being used in different laboratories.

Acceptable difference between two results (difference two-sigma limit (d2s)) as an index of precision is the maximum acceptable difference between two results obtained on test portions of the same material tested by two different laboratories. The index, d2s, is the difference between two individual test results that would be equalled or exceeded in only one case in twenty in the normal and correct operation of the method. The index is calculated by multiplying the multi-laboratory standard deviation (1s) by the factor $2\sqrt{2}$ (2.83).

Sample mean or average is the sum of all observations divided by the total number of observations.

Median is synonymous with the middle and the **sample median** is the middle value of a list of test results when the observations are ordered from smallest to largest in magnitude. After rearranging the observations in increasing order (from most negative to most positive), the **sample median** is the *single middle value* in the ordered list, if n is odd, or the *average of the two middle values* in the ordered list, if n is even, where n equals the number of observations.

Standard deviation is the most usual measure of the dispersion of observed values or results expressed as the positive square root of the variance.

Variance is a measure of the squared dispersion of observed values or measurements expressed as a function of the sum of the squared deviations from the population mean or sample average.

Outlier is a measurement that, for a specific degree of confidence, is not part of the population. In this study, an outlier is generally three or more standard deviations from the mean, giving a confidence level of ninety-nine percent. If a laboratory test result is classified as an outlier, it means that something went wrong either with the sample or in the laboratory.

Appendix B1: List of Participants

2009 Participants List Ministry of Transportation Aggregate and Soil Proficiency Sample Testing Program For further information on this program, contact: Mark Vasavithasan (416) 235-4901, or Stephen Senior (416) 235-3734	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
A. L. Blair Construction Limited Moose Creek, ON Mr. Justin Blair Tel: 613 538-2271	✓	✓				✓	✓							✓				
AGS Associates Inc. Scarborough, ON Mr. Amjed Siddiqui Tel: 416 299-3655	✓	✓		✓	✓	✓	✓				✓	✓		✓	✓			
AME - Materials Engineering Caledon, ON Mr. Scott Crowley Tel: 905 840-5914	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	
AME - Materials Engineering Gormley, ON Mr. Blaine Dobson Tel: 905 640-7772	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	
AME - Materials Engineering - Ottawa Ottawa, ON Mr. Steve Goodman Tel: 613 726-3037	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	
AME - Materials Engineering (24-165) Caledon, ON Mr. Scott Crowley Tel: 905 840-5914	✓	✓				✓	✓							✓	✓			
AME - Materials Engineering (24-270) Caledon, ON Mr. Scott Crowley Tel: 905 840-5914	✓	✓				✓	✓							✓	✓			
AME - Materials Engineering (24-271) Caledon, ON Mr. Scott Crowley Tel: 905 840-5914	✓	✓				✓	✓							✓	✓			
AME - Materials Engineering (24-297) Caledon, ON Mr. Scott Crowley Tel: 905 840-5914	✓	✓				✓	✓							✓	✓			
AME - Materials Engineering (24-298) Caledon, ON Mr. Scott Crowley Tel: 905 840-5914	✓	✓				✓	✓							✓	✓			
AME - Materials Engineering (24-384) Caledon, ON Mr. Scott Crowley Tel: 905 840-5914	✓	✓				✓	✓							✓	✓			
AME - Materials Engineering (24-911) Caledon, ON Mr. Scott Crowley Tel: 905 840-5914	✓	✓				✓	✓							✓	✓			
AME - Materials Engineering (24-912) Caledon, ON Mr. Scott Crowley Tel: 905 840-5914	✓	✓				✓	✓							✓	✓			
AMEC Earth & Environmental Ltd Scarborough, ON Mr. S. Sufi Tel: 416 751-6565	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓

2009 Participants List Ministry of Transportation Aggregate and Soil Proficiency Sample Testing Program For further information on this program, contact: Mark Vasavithasan (416) 235-4901, or Stephen Senior (416) 235-3734	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
AMEC Earth & Environmental Ltd. Hamilton, ON Ms. Hoda Seddik Tel: 905 312-0700	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
AMEC Earth & Environmental Ltd. Orillia, ON Mr. S. Baskaran Tel: 416 751-6565	✓	✓				✓								✓	✓			
AMEC Earth & Environmental Ltd. Cambridge, ON Mr. Lou Maier Tel: 519 969-7530	✓	✓		✓		✓	✓				✓	✓		✓	✓	✓	✓	✓
AMEC Earth & Environmental Ltd. Windsor, ON Mr. Shane MacLeod Tel: 519 653-3570	✓	✓		✓		✓	✓							✓	✓		✓	
Bernt Gilbertson Enterprises Richards Landing, ON Mr. Scott Eddy Tel: 705 246-2076	✓	✓				✓	✓							✓				
Bertrand Construction L'Original, ON Ms. Alain Bernard Tel: 613 675-4614	✓	✓				✓	✓				✓	✓		✓				
BOT Construction –Main Lab Oakville, ON Mr. Vicks Sellathurai Tel: 905 827-3250	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓	✓		✓	✓
BOT Construction -Mobile Oakville, ON Mr. Vicks Sellathurai Tel: 905 827-3250	✓	✓				✓	✓							✓	✓			
Bruno's Contracting (Thunder Bay) Ltd. Thunder Bay, ON Mr. Silvio DiGregorio Tel: 807 623-1855	✓	✓				✓	✓							✓	✓			
C. H. Demill Holdings Shannonville, ON Ms. Darlene Quinn Tel: 613 967-3722	✓	✓				✓	✓							✓				
C. Villeneuve Construction Hearst, ON Mr. Charles Harris Tel: 705 372-1838	✓	✓		✓		✓	✓							✓	✓			
C.T. Soil & Materials Testing Inc. Windsor, ON Mr. Thomas O'Dwyer Tel: 519 966-8863	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
Caledon Sand & Gravel Ltd. Caledon, ON Mr. Dean Glenn Tel: 519 927-5224	✓	✓				✓	✓							✓				
Capital Paving Inc. Guelph, ON Mr. Mark Latyn Tel: 519 822-4511	✓	✓				✓	✓							✓	✓			
CBM Aggregates - Aberfoyle Toronto, ON Mr. Leigh Mugford Tel: 416 806-3590	✓	✓				✓	✓							✓				
CBM Aggregates – Brighton Toronto, ON Mr. Leigh Mugford Tel: 416 806-3590	✓	✓				✓	✓							✓				
CBM Aggregates – Cambridge Toronto, ON Mr. Leigh Mugford Tel: 416 806-3590	✓	✓				✓	✓							✓				

2009 Participants List Ministry of Transportation Aggregate and Soil Proficiency Sample Testing Program For further information on this program, contact: Mark Vasavithasan (416) 235-4901, or Stephen Senior (416) 235-3734	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
CBM Aggregates – Pinewood Toronto, ON Mr. Leigh Mugford Tel: 416 806-3590	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓				
CBM Aggregates – Sunderland Toronto, ON Mr. Leigh Mugford Tel: 416 806-3590	✓	✓				✓	✓							✓				
CBM Leaside Lab Toronto, ON Mr. Stephen Parkes Tel: 416 423-2439	✓	✓		✓	✓	✓	✓			✓	✓	✓	✓	✓				
Chung & Vander Dollen Engineering Limited, Kitchener, ON Mr. William Evans Tel: 519 742-8979	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
City of Sault Ste Marie Sault Ste Marie, ON Mr. John Sloan Tel: 705 946-9918	✓	✓				✓								✓				
CMT Engineering Inc. St. Clements, ON Mr. Tim Salter Tel: 519 699-5775	✓	✓				✓	✓							✓	✓			
COCO Paving Inc. – Belleville Belleville, ON Mr. Michael Haisma Tel: 613 962-3461	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓		✓	
COCO Paving Inc. – Mobile No. 1 Windsor, ON Mr. Ishaq Syed Tel: 519 948-7133	✓	✓		✓		✓	✓							✓	✓			
COCO Paving Inc. – Moodie Ottawa, ON Mr. Brad Gooderham Tel: 613 913-8956	✓	✓		✓		✓	✓				✓	✓		✓				
COCO Paving Inc. - Toronto Toronto, ON Mr. Andrew Pahalan Tel: 416 633-9670	✓	✓		✓		✓	✓							✓				
COCO Paving Inc. - Windsor Windsor, ON Mr. Ishaq Syed Tel: 519 948-7133	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
Coffey Geotechnics Inc. Toronto, ON Mr. Andrew Mendonca Tel: 416 213-1255	✓	✓				✓	✓							✓	✓	✓	✓	✓
Coffey Geotechnics Inc. Markham, ON Mr. Cecil Wong Tel: 905 474-9255	✓	✓				✓									✓	✓	✓	✓
Concrete Materials Lab, Dept. of Engineering, U. of Toronto Dr. R. D. Hooton Tel: 416 978-5912													✓					
Construction Control Inc. Woodbridge, ON Mr. Anthony Davis Tel: 905 856-1438	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Construction Testing Asphalt Lab Oakville, ON Mr. Peter Lung Tel: 905 469-6352	✓	✓		✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
Cornwall Gravel Company Limited Cornwall, ON Ms. N. Hollingsworth Tel: 613 932-6571	✓	✓				✓	✓							✓				

2009 Participants List Ministry of Transportation Aggregate and Soil Proficiency Sample Testing Program For further information on this program, contact: Mark Vasavithasan (416) 235-4901, or Stephen Senior (416) 235-3734	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
Cox Construction Limited Guelph, ON Mr. Andrew Smith Tel: 519 824-6570	✓	✓		✓		✓	✓							✓	✓			
Cruickshank Construction Ltd Kingston, ON Mr. Tim Bilton Tel: 613 542-8508	✓	✓		✓		✓	✓							✓				
Cruickshank Construction Ltd Morrisburg, ON Mr. Dan Byvelds Tel: 613 543-2978	✓	✓				✓	✓							✓	✓			
D. F. Elliott Consulting Engineering New Liskeard, ON Mr. Brad Gilbert Tel: 705 647-6871	✓	✓				✓	✓							✓	✓			
Danford Construction Madoc, ON Mr. Al Danford Tel: 613 473-2468	✓	✓				✓	✓							✓				
Davroc Testing Laboratories Inc. Brampton, ON Mr. Sal Fasullo Tel: 905 792-7792	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DBA Engineering Limited Markham, ON Mr. Andy Burleigh Tel: 905 940-8383	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DBA Engineering Limited Mobile 10 Markham, ON Mr. Andy Burleigh Tel: 905 940-8383	✓	✓				✓	✓							✓	✓			
DBA Engineering Limited Mobile 5 Markham, ON Mr. Andy Burleigh Tel: 905 940-8383	✓	✓				✓	✓							✓	✓			
DBA Engineering Limited Mobile 7 Markham, ON Mr. Andy Burleigh Tel: 905 940-8383	✓	✓				✓	✓							✓	✓			
DBA Engineering Ltd. Kingston, ON Mr. Mark McClelland Tel: 613 389-1781	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓
Department of Civil Engineering Ryerson University, Toronto Dr. S. Medhat Tel: 416 979-5000 x 6457													✓					
District Municipality of Muskoka Bracebridge, ON Mr. Dave Wood Tel: 705 645-6764	✓	✓				✓								✓	✓	✓	✓	
Drain Bros Excavating Ltd. Lakefield, ON Mr. Elton Neuman Tel: 705 639-2301	✓	✓				✓	✓				✓	✓		✓	✓			
DST Consulting Engineers Inc. Kenora, ON Mr. Neil Johnson Tel: 807 548-2383	✓	✓				✓	✓							✓	✓			
DST Consulting Engineers Inc. Thunder Bay, ON Dr. Myint Win Bo Tel: 807 623-2929	✓	✓	✓	✓		✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
DST Consulting Engineers Inc. Ottawa, ON Mr. Bashar Hammoud Tel: 613 748-1415	✓	✓				✓	✓							✓	✓	✓	✓	

2009 Participants List Ministry of Transportation Aggregate and Soil Proficiency Sample Testing Program For further information on this program, contact: Mark Vasavithasan (416) 235-4901, or Stephen Senior (416) 235-3734	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
Dufferin Aggregates - Aberfoyle Guelph, ON Ms. Janet Bherer Tel: 905 878-2732	✓	✓				✓	✓							✓				
Dufferin Aggregates - Acton Acton, ON Ms. Janet Bherer Tel: 905 878-2732	✓	✓				✓	✓							✓				
Dufferin Aggregates - Blair Pit Blair, ON Ms. Janet Bherer Tel: 905 878-2732	✓	✓				✓	✓							✓				
Dufferin Aggregates - Carden Brechin, ON Ms. Janet Bherer Tel: 905 878-2732	✓	✓				✓	✓							✓				
Dufferin Aggregates - Cayuga Cayuga, ON Ms. Janet Bherer Tel: 905 878-2732	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓			
Dufferin Aggregates - Flamborough Dundas, ON Ms. Janet Bherer Tel: 905 878-2732	✓	✓				✓	✓							✓				
Dufferin Aggregates - Kitchener Kitchener, ON Ms. Janet Bherer Tel: 905 878-2732	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓			✓	
Dufferin Aggregates - Milton Milton, ON Ms. Janet Bherer Tel: 905 878-2732	✓	✓				✓	✓							✓				
Dufferin Aggregates - Mosport Orono, ON Ms. Janet Bherer Tel: 905 878-2732	✓	✓				✓	✓							✓				
Dufferin Aggregates - Putnam Putnam, ON Ms. Janet Bherer Tel: 905 878-2732	✓	✓				✓	✓							✓				
Dufferin Construction Limited - Cayuga Oakville, ON Mr. Waqas Syed Tel: 905 827-5750	✓	✓		✓		✓	✓							✓	✓			
Dufferin Construction Limited - Mobile 1 Oakville, ON Mr. Waqas Syed Tel: 905 827-5750	✓	✓		✓		✓	✓							✓	✓			
Dufferin Construction Limited - Mobile 2 Oakville, ON Mr. Waqas Syed Tel: 905 827-5750	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Dufferin Construction Limited - Mobile 3 Oakville, ON Mr. Waqas Syed Tel: 905 827-5750	✓	✓		✓		✓	✓							✓	✓			
Dufferin Construction Ltd. (QC) - Bronte Oakville, ON Mr. Waqas Syed Tel: 905 827-5750	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
Dunn Paving Limited Tecumseh, ON Mr. Marcel Gauvin Tel: 519 727-3838	✓	✓				✓	✓							✓	✓			
E.C. King Contracting Lab #1 Owen Sound, ON Mr. Steve Duncan Tel: 519 376-6140	✓	✓				✓	✓							✓	✓			

2009 Participants List

Ministry of Transportation Aggregate and Soil Proficiency Sample Testing Program

For further information on this program, contact:

Mark Vasavithasan (416) 235-4901, or
Stephen Senior (416) 235-3734

	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
Esko Savela & Son Contracting Inc. Thunder Bay, ON Mr. Esko Savela Tel: 807 983-2097	✓	✓				✓	✓							✓				
Fermar Construction Limited Rexdale, ON Mr. Ramon Meza Tel: 416 675-3550	✓	✓		✓		✓	✓							✓	✓			
Fowler Construction Company Bracebridge, ON Mr. Ross Elliott Tel: 705 645-2214	✓	✓		✓		✓	✓							✓	✓			
Fowler Construction Company – Mobile 1 Bracebridge, ON Mr. Ross Elliott Tel: 705 645-2214	✓	✓		✓		✓	✓							✓	✓			
G. Tackaberry & Sons Construction Co. Ltd., Athens, ON Mr. Paul Rodgers Tel: 613 924-2634	✓	✓				✓	✓							✓	✓			
Gazzola Paving Ltd. Etobicoke, ON Mr. S. Andualem Tel: 416 675-9803	✓	✓				✓	✓							✓				
Geo Terre Limited Brampton, ON Mr. Ivan Corbett Tel: 905 455-5666	✓	✓				✓	✓							✓	✓	✓	✓	
Geo-Logic Inc. Peterborough, ON Mr. Wayne Rayfuse Tel: 705 749-3317	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓
Geo-Logic Inc. Pembroke, ON Ms. Elizabeth Reid Tel: 613 735-8361	✓	✓				✓	✓							✓	✓			
Golder Associates Ltd. Cambridge, ON Ms. Alana Smith Tel: 519 620-1222	✓	✓		✓		✓	✓							✓	✓	✓	✓	
Golder Associates Ltd. Surrey, B.C. Mrs. Emily Kwok Tel: 604 591-6616	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Golder Associates Ltd. London, ON Mr. Chris Sewell Tel: 519 652-0099	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
Golder Associates Ltd. Mississauga, ON Ms. Mariana Manojlovic Tel: 905 567-4444	✓	✓				✓								✓	✓	✓	✓	✓
Golder Associates Ltd. Ottawa, ON Mr. Chris Mangione Tel: 613 224-5864	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Golder Associates Ltd. Sudbury, ON Ms. Sylvie LaPorte Tel: 705 524-6861	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
Golder Associates Ltd. Whitby, ON Mr. John Watkins Tel: 905 723-2727	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Golder Associates Ltd. Windsor, ON Mr. Roy Walsh Tel: 519 250-3733	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓

2009 Participants List Ministry of Transportation Aggregate and Soil Proficiency Sample Testing Program For further information on this program, contact: Mark Vasavithasan (416) 235-4901, or Stephen Senior (416) 235-3734	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
Golder Associates Ltd. – Lab No. 3 Surrey, B.C. Mrs. Emily Kwok Tel: 604 591-6616								✓										
Graham Brothers Construction Limited Brampton, ON Mr. Greg Thompson Tel: 905 453-1200	✓	✓		✓		✓	✓				✓	✓		✓	✓		✓	
Greenwood Aggregates Orangeville, ON Mr. Andrew Raymond Tel: 519 941-0732	✓	✓		✓		✓	✓			✓	✓	✓		✓			✓	
Harold Sutherland Construction Ltd. Kemble, ON Mr. Roland Leigh Tel: 519 376-3506	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓			
Houle Chevrier Engineering Limited Carp, ON Mr. Andrew Chevrier Tel: 613 836-1422	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓
Huron Construction Co. Ltd. Chatham, ON Mr. David Smith Tel: 519 354-0170	✓	✓				✓	✓							✓	✓			
Inspec-sol Inc. Kingston, ON Mr. Mark Paterson Tel: 613 389-9812	✓	✓				✓	✓							✓	✓			
Inspec-Sol Inc. Mississauga, ON Mr. Karl Roechner Tel: 905 712-4771	✓	✓				✓								✓	✓	✓	✓	
Inspec-sol Inc. Ottawa, ON Mr. Joseph B. Bennett Tel: 613 727-0895	✓	✓				✓	✓							✓	✓			
Intratech Engineering Laboratories Inc. Scarborough, ON Mr. Frank Miles Tel: 416 754-2077	✓	✓		✓	✓	✓	✓			✓				✓	✓	✓	✓	✓
J & P Leveque Bros. Haulage Ltd. Bancroft, ON Mr. Shawn Fransky Tel: 613 332-5533	✓	✓				✓	✓				✓	✓		✓	✓		✓	
J & P Leveque Bros. Ltd. - Mobile 1 Bancroft, ON Mr. Shawn Fransky Tel: 613 332-5533	✓	✓				✓	✓				✓	✓		✓	✓		✓	
Jacques Whitford Stantec Limited Ottawa, ON Mr. Brian Prevost Tel: 613 738-0708	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Jacques Whitford Stantec Limited Markham, ON Ms. Brani Vujanovic Tel: 905 474-7700	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Jacques Whitford Stantec Limited Burlington, ON Mr. Eric Theriault Tel: 905 531-3927	✓	✓		✓		✓	✓				✓	✓		✓	✓	✓	✓	✓
Jagger Hims Limited Division of Genivar Peterborough, ON Mr. Steve Ash Tel: 705 743-6850	✓	✓				✓	✓							✓	✓		✓	
John D. Paterson & Associates Nepean, ON Mr. Curtis Beadow Tel: 613 226-7381	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓

2009 Participants List Ministry of Transportation Aggregate and Soil Proficiency Sample Testing Program For further information on this program, contact: Mark Vasavithasan (416) 235-4901, or Stephen Senior (416) 235-3734	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
John D. Paterson & Associates North Bay, ON Mr. Shawn Nelson Tel: 707 472-5331	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
K. J. Beamish Construction - Mobile 1 King City, ON Mr. Chad Henderson Tel: 905 833-4666	✓	✓				✓	✓							✓	✓			
K. J. Beamish Construction - Mobile 2 King City, ON Mr. Chad Henderson Tel: 905 833-4666	✓	✓				✓	✓							✓	✓			
K.J. Beamish Construction King City, ON Mr. Chad Henderson Tel: 905 833-4666	✓	✓		✓		✓	✓	✓		✓	✓	✓		✓	✓		✓	
Karson Kartage & Konstruction Carp, ON Mr. Cam MacDonald Tel: 613 831-0717	✓	✓		✓	✓	✓	✓			✓	✓	✓	✓	✓				
Lafarge Canada Montreal, QUE, Ms. M. de Grosbois Tel: 514 738-1202													✓					
Lafarge Canada - Brechin Plant Brechin, ON Ms. Christine Crumbie Tel: 705 484-5225	✓	✓				✓	✓				✓	✓		✓				
Lafarge Canada - Coldwater Plant Cold Water, ON Mr. Jim Leonard Tel: 705 484-5225	✓	✓				✓	✓							✓				
Lafarge Canada - Mosport Lab Orono, ON Mr. Peter Hill Tel: 905 983-9260	✓	✓				✓	✓							✓				
Lafarge Canada - Orillia Lab Hawkestone, ON Ms. Christine Crumbie Tel: 705 484-5225	✓	✓				✓	✓							✓				
Lafarge Canada Inc - Dundas Quarry Dundas, ON Mr. Ryan Smith Tel: 905 527-3671	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓	✓			
Lafarge Canada Inc. - Caledon Caledon, ON Mr. John Kroeze Tel: 519 927-1113	✓	✓				✓	✓							✓				
Lafarge Canada Inc. - Cambridge Cambridge, ON Mr. Walter Day Tel: 519 319-9128	✓	✓				✓	✓							✓				
Lafarge Canada Inc. - Fonthill Fonthill, ON Mr. Jim Vingerhoets Tel: 905 892-2686	✓	✓				✓	✓							✓				
Lafarge Canada Inc. - Hamilton Hamilton, ON Mr. Chris Thomas Tel: 905 522-7735	✓	✓		✓	✓	✓	✓			✓	✓	✓	✓	✓			✓	
Lafarge Canada Inc. - London London, ON Mr. Walter Day Tel: 519 319-9128	✓	✓				✓	✓							✓				
Lafarge Canada Inc. - Meldrum Meldrum Bay, ON Mr. Jeff Middleton Tel: 705 283-3011	✓	✓				✓	✓							✓				

2009 Participants List Ministry of Transportation Aggregate and Soil Proficiency Sample Testing Program For further information on this program, contact: Mark Vasavithasan (416) 235-4901, or Stephen Senior (416) 235-3734	LS-601 Wash Pass 75μm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
Lafarge Canada Inc. - Ottawa Ottawa, ON Mr. Fred Douglas Tel: 613 837-4223	✓	✓		✓	✓	✓	✓				✓	✓		✓	✓			
Lafarge Canada Inc. – Pt. Anne Quarry Brechin, ON Ms. Christine Crumbie Tel: 705 484-5225	✓	✓				✓	✓							✓				
Lafarge Canada Inc. - Stouffville Stouffville, ON Ms. Christine Crumbie Tel: 905 640-7092	✓	✓		✓		✓	✓							✓				
Lafarge Construction Materials Ltd. Brockville, ON Mr. Paul Arkeveld Tel: 613 342-0262	✓	✓				✓	✓			✓				✓				
Lafarge Construction Materials Ltd. Glenburnie, ON Mr. Paul Arkeveld Tel: 613 342-0262	✓	✓				✓	✓							✓				
Landtek Limited Hamilton, ON Mr. Paul Anderson Tel: 905 383-3733	✓	✓		✓		✓	✓				✓	✓		✓	✓	✓	✓	✓
Lavis Contracting Co. Limited Clinton, ON Mr. Allan Gardner Tel: 519 482-3694	✓	✓		✓		✓	✓							✓	✓			
Law Engineering (London) Inc. London, ON Mr. Joe Law Tel: 519 680-9991	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓
Leo Alarie and Sons Ltd. - Mobile 10060 Timmins, ON Mr. John Corkill Tel: 705 268-2106	✓	✓				✓	✓							✓				
LVM-John Emery Geotechnical Toronto, ON Mr. Dawit Amar Tel: 416 213-1060	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
LVM-Naylor Engineering Associates Ltd. Kitchener, ON Ms. Anne Allen Tel: 519 741-1313	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓
LVM-Naylor Engineering Associates Ltd. Branford, ON Mr. Dave Baillie Tel: 519 720-0078	✓	✓				✓	✓							✓	✓	✓	✓	
LVM-Naylor Engineering Associates Ltd. Stratford, ON Mr. Mathew Smith Tel: 519 271-0101	✓	✓				✓	✓							✓	✓	✓	✓	
M. J. Labelle Co. Limited - Mobile 1 Cochrane, ON Mr. Peter Osmar Tel: 705 272-4201	✓	✓				✓								✓	✓			
M. J. Labelle Co. Limited - Mobile 2 Cochrane, ON Mr. Peter Osmar Tel: 705 272-4201	✓	✓				✓								✓	✓			
M. R. Wright & Associates Sault Ste. Marie, ON Mr. Daren Stadnisky Tel: 705 945-5090	✓	✓		✓		✓	✓				✓	✓		✓	✓	✓	✓	
McAsphalt Engineering Services Toronto, ON Mr. Keith Davidson Tel: 416 281-8181	✓	✓		✓		✓	✓							✓	✓			

2009 Participants List

Ministry of Transportation Aggregate and Soil Proficiency Sample Testing Program

For further information on this program, contact:

Mark Vasavithasan (416) 235-4901, or
Stephen Senior (416) 235-3734

	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
Merlex Engineering Limited North Bay, ON Mr. Mike Merleau Tel: 705 476-2550	✓	✓				✓	✓							✓	✓	✓	✓	✓
Mill-Am Corporation - Mobile 890901 Oldcastle, ON Mr. Abdule Saifan Tel: 519 945-7441	✓	✓				✓	✓							✓	✓			
Miller Northwest - Mobile 1 Dryden, ON Mr. Ross Reynolds Tel: 807 223-2844	✓	✓		✓		✓	✓							✓	✓			
Miller Northwest - Mobile 87526 Dryden, ON Mr. Ross Reynolds Tel: 807 223-2844	✓	✓		✓		✓	✓							✓	✓			
Miller Paving Limited - Carden Mobile Gormley, ON Mr. Narayan Hanasoge Tel: 905 726-9518	✓	✓				✓	✓							✓				
Miller Paving Limited - Carden Quarry Gormley, ON Mr. Narayan Hanasoge Tel: 905 726-9518	✓	✓				✓	✓							✓				
Miller Paving Limited - Markham Gormley, ON Mr. Narayan Hanasoge Tel: 905 726-9518	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓	✓		✓	
Miller Paving Limited - Mobile 8661 North Bay, ON Mr. Herb Villneff Tel: 705 472-3312	✓	✓				✓	✓							✓	✓			
Miller Paving Limited – Port Colborne Gormley, ON Mr. Narayan Hanasoge Tel: 905 726-9518	✓	✓		✓		✓	✓				✓	✓		✓	✓			
Miller Paving Limited - Whitby Gormley, ON Mr. Narayan Hanasoge Tel: 905 726-9518	✓	✓				✓	✓							✓	✓			
Miller Paving Ltd. – Mobile 60853 North Bay, ON Mr. Herb Villneff Tel: 705 472-3312	✓	✓		✓		✓	✓							✓	✓			
Miller Paving Ltd. – Mobile 8660 North Bay, ON Mr. Herb Villneff Tel: 705 472-3312	✓	✓				✓	✓							✓	✓			
Miller Paving Northern - Mobile 1084 North Bay, ON Mr. Herb Villneff Tel: 705 472-3312	✓	✓		✓		✓	✓							✓	✓			
Miller Paving Northern - Mobile 1254 North Bay, ON Mr. Herb Villneff Tel: 705 472-3312	✓	✓		✓		✓	✓				✓	✓		✓	✓			
Miller Paving Northern - Mobile 50612 North Bay, ON Mr. Herb Villneff Tel: 705 472-3312	✓	✓		✓		✓	✓							✓	✓			
Miller Paving Northern - Mobile 60889 North Bay, ON Mr. Herb Villneff Tel: 705 472-3312	✓	✓		✓		✓	✓							✓	✓			
Miller Paving Northern - Mobile 60900 North Bay, ON Mr. Herb Villneff Tel: 705 472-3312	✓	✓		✓		✓	✓							✓	✓			

2009 Participants List Ministry of Transportation Aggregate and Soil Proficiency Sample Testing Program For further information on this program, contact: Mark Vasavithasan (416) 235-4901, or Stephen Senior (416) 235-3734	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
Ministry of Transportation Downsview, ON Mr. Stephen Senior Tel: 416 235-3734	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MNA Engineering Limited Scarborough, ON Mr. Peter Balendran Tel: 416 757-8882	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
National Testing Laboratories Limited Winnipeg, Manitoba Mr. Don Flatt Tel: 204 488-6999	✓	✓	✓	✓	✓	✓	✓				✓	✓		✓	✓	✓	✓	✓
Nelson Aggregate Co. Beamsville, ON Mr. Terry Scambato Tel: 905 563-8226	✓	✓				✓	✓							✓				
Nelson Aggregate Co. Burlington, ON Mr. Mike Rook Tel: 905 335-5251	✓	✓				✓	✓							✓				
Nelson Aggregate Co. Orillia, ON Mr. Chris Roote Tel: 705 325-2264	✓	✓				✓	✓							✓				
Peto MacCallum Limited Barrie, ON Mr. Andrew Jones Tel: 705 734-3900	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Peto MacCallum Limited Hamilton, ON Mr. Everett L. Truax Tel: 905 561-2231	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Peto MacCallum Limited Kitchener, ON Mr. Tony Smith Tel: 519 893-7500	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
Peto MacCallum Limited Toronto, ON Mr. Alnoor Nathoo Tel: 416 785-5110	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Peto MacCallum Limited – Mobile 1 Toronto, ON Mr. Alnoor Nathoo Tel: 416 785-5110	✓	✓				✓								✓	✓			
Pioneer Construction Inc. Sault Ste. Marie, ON Ms. Shelley Geiling Tel: 705 541-2280	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓			
Pioneer Construction Inc. Copper Cliff, ON Mr. David Pilkey Tel: 705 693-1363	✓	✓		✓		✓	✓	✓		✓	✓	✓		✓	✓			
Pioneer Construction Inc. - Mobile 1 Garson, ON Mr. David Pilkey Tel: 705 693-1363	✓	✓				✓	✓							✓	✓			
Pioneer Construction Inc. – Mobile 2 Garson, ON Mr. David Pilkey Tel: 705 693-1363	✓	✓				✓	✓							✓	✓			
Pioneer Construction Inc. - Mobile 3 Kenora, ON Ms. Shelley Geiling Tel: 705 541-2280	✓	✓				✓	✓							✓	✓			
Pioneer Construction Inc. - Mobile C 1 Sault Ste. Marie, ON Ms. Shelley Geiling Tel: 705 541-2280	✓	✓				✓	✓							✓	✓			

2009 Participants List

Ministry of Transportation
Aggregate and Soil
Proficiency Sample
Testing Program

For further information on this program, contact:

Mark Vasavithasan (416) 235-4901, or
Stephen Senior (416) 235-3734

	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
Pioneer Construction Inc. - Mobile C 2 Thunder Bay, ON Ms. Shelley Geiling Tel: 705 541-2280	✓	✓				✓	✓							✓	✓			
Pioneer Construction Inc. - Thunder Bay Thunder Bay, ON Ms. Shelley Geiling Tel: 705 541-2280	✓	✓		✓		✓	✓							✓	✓			
Port Colborne Quarries Inc. Port Colborne, ON Mr. Tim Cassibo Tel: 905 834-3647	✓	✓				✓	✓							✓				
Precision Age Aggregate Testing Ltd. Thunder Bay, ON Mr. Bill Werbowetski Tel: 807 475-6985								✓										
Preston Sand & Gravel Kitchener, ON Mr. Matthew Bell Tel: 519 579-1248	✓	✓				✓	✓							✓				
R. W. Tomlinson Limited Ottawa, ON Mr. Bert Hendriks Tel: 613 822-1867	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓		✓	✓
R. W. Tomlinson Limited – Mobile No. 1 Gloucester, ON Mr. Bert Hendriks Tel: 613 822-1867	✓	✓				✓	✓							✓				
R.S Wilson Materials Testing & Inspection Sault Ste. Marie, ON Mr. Robert Wilson Tel: 705 759-2881	✓	✓				✓								✓	✓			
Regional Municipality of Durham Whitby, ON Mr. Joeman Ng Tel: 905 655-3344	✓	✓				✓	✓							✓	✓			
Sarafinchin Associates Limited Rexdale, ON Mr. Scott Jeffrey Tel: 416 674-1770	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Shaba Testing Services Limited Chaput Hughes, ON Mr. Lad Shaba Tel: 705 567-4187	✓	✓				✓	✓							✓	✓			
Shaheen Peaker Thompson Limited Oshawa ON Mr. Dave Thompson Tel: 905 436-9028	✓	✓		✓	✓	✓	✓			✓				✓	✓	✓	✓	✓
Smelter Bay Aggregates Inc. Thessalon, ON Mr. Charles Hernden Tel: 705 842-3908	✓	✓				✓	✓							✓				
Soil Engineers Limited Scarborough, ON Mr. S. Sanjeevan Tel: 416 754-8515	✓	✓				✓	✓							✓	✓	✓	✓	✓
St Lawrence Testing & Inspection Co. Ltd. Cornwall, ON Mr. Gib McIntee Tel: 613 938-2521	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
Steed and Evans Limited Heidelberg, ON Mr. Richard Marco Tel: 519 699-4646	✓	✓		✓		✓	✓							✓				
Teranorth Construction & Engineering Limited, Sudbury, ON Mr. James Bot Tel: 705 523-1540	✓	✓				✓	✓							✓	✓			

2009 Participants List Ministry of Transportation Aggregate and Soil Proficiency Sample Testing Program For further information on this program, contact: Mark Vasavithasan (416) 235-4901, or Stephen Senior (416) 235-3734	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
Terraprobe Testing Limited Brampton, ON Mr. Chris Elvidge Tel: 905 796-2650	✓	✓		✓		✓	✓	✓			✓	✓		✓	✓	✓	✓	✓
Terraprobe Testing Limited Barrie, ON Mr. Brian Jackson Tel: 705 739-8355	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Terraprobe Testing Limited Stoney Creek, ON Mr. Gerry Muckle Tel: 905 643-7560	✓	✓		✓		✓	✓			✓				✓	✓	✓	✓	✓
Terraprobe Testing Limited Sudbury, ON Mr. Dennis Paquette Tel: 705 670-0460	✓	✓				✓	✓							✓	✓	✓	✓	✓
Terraspec Engineering Peterborough, ON Mr. Shane Galloway Tel: 705 743-7880	✓	✓				✓								✓	✓	✓	✓	✓
The Miller Group Materials Research Lab Gormley, ON Mr. Narayan Hanasoge Tel: 905 726-9518	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	
The Murray Group Moorefield, ON Mr. Chris Hodgson Tel: 519 323-4411	✓	✓				✓	✓							✓				
Thomas Cavanagh Construction Ltd. Ashton, ON Mr. Phil White Tel: 613 259-2670	✓	✓				✓	✓							✓				
Thunder Bay Testing and Engineering Thunder Bay, ON Mr. Tim Fummerton Tel: 807 624-5162	✓	✓		✓		✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓
Thurber Engineering Limited Oakville, ON Dr. P. K. Chatterji Tel: 905 829-8666	✓	✓				✓	✓							✓	✓	✓	✓	✓
Trow Associates Inc. Timmins, ON Mr. Lyne Carriere Tel: 705 268-4351	✓	✓				✓	✓							✓	✓			
Trow Associates Inc. Brampton, ON Dr. Salman Bhutta Tel: 905 793-9800	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Trow Associates Inc. London, ON Mr. David Speller Tel: 519 453-1480	✓	✓				✓	✓							✓	✓			
Trow Associates Inc. Stoney Creek, ON Mr. James Clunas Tel: 905 573-4000	✓	✓				✓	✓							✓	✓	✓	✓	
Trow Associates Inc. Sudbury, ON Mr. Rob Ferguson Tel: 705 674-9681	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
Trow Associates Inc. Ottawa, ON Mr. Ismail M. Taki Tel: 613 225-9940	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓
Trow Associates Inc. Thunder Bay, ON Mr. Jason Goodman Tel: 807 623-9495	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓		✓	

2009 Participants List Ministry of Transportation Aggregate and Soil Proficiency Sample Testing Program For further information on this program, contact: Mark Vasavithasan (416) 235-4901, or Stephen Senior (416) 235-3734	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
Trow Associates Inc. Barrie, ON Mr. Leigh Knegt Tel: 705 734-6222	✓	✓				✓	✓							✓	✓	✓	✓	✓
True Grit Consulting Ltd. Thunder Bay, ON Mr. Darryl Kelly Tel: 807 626-5640	✓	✓				✓	✓							✓	✓			
Vicdom Sand and Gravel Limited Uxbridge, ON Mr. Bruno Giordano Tel: 905 649-2193	✓	✓				✓	✓							✓				
Walker Aggregates Inc. Thorold, ON Mr. Tom Risi Tel: 905 680-3750	✓	✓		✓	✓	✓	✓				✓	✓		✓				
Walker Aggregates Inc. Duntroon, ON Mr. Tom Risi Tel: 705 445-2300	✓	✓				✓	✓							✓				

Appendix B2: List of Participants

2009 Participants List Ministry of Transportation Superpave Aggregate Consensus Property Testing Program For further information on this program, contact: Mark Vasavithasan (416) 235-4901 or Stephen Senior (416) 235-3734	ASTM D 1252/AASHTO T 304 - Uncompacted Void Content of Fine Aggregate	ASTM D 4219/AASHTO T 176 – Sand Equivalent Value of Fine	ASTM D 5821 – Percent of Fractured Particles in Coarse Aggregate	ASTM D 4791 – Percent Flat Particles, Elongated Particles or Flat & Elongated Particles in Coarse Aggregate
AME -Materials Engineering Gormley, ON Mr. Blaine Dobson Tel: 905 640-7772	✓	✓	✓	✓
AME -Materials Engineering Caledon, ON Mr. Scott Crowley Tel: 905 840-5914	✓	✓	✓	✓
AMEC Earth & Environmental Limited Hamilton, ON Ms. Hoda Seddik Tel: 905 312-0700	✓	✓	✓	✓
AMEC Earth & Environmental Limited Scarborough, ON Mr. S. Sufi Tel: 416 751-6565	✓	✓	✓	✓
AMEC Earth & Environmental Limited Windsor, ON Mr. Shane MacLeod Tel: 519 969-7530	✓	✓	✓	✓
BOT Construction Oakville, ON Mr. Vicks Sellathurai Tel: 905 827-3250	✓	✓	✓	✓
C. Villeneuve Construction Hearst, ON Mr. Charles Harris Tel: 705 372-1838	✓	✓	✓	✓
COCO Paving Inc. Windsor, ON Mr. Ishaq Syed Tel: 519 948-7133	✓	✓	✓	✓
COCO Paving Inc. Belleville, ON Mr. Michael Haisma Tel: 613 962-3461	✓	✓	✓	✓
COCO Paving Inc. Ottawa, ON Mr. Brad Gooderham Tel: 613 913-8956	✓	✓	✓	✓
COCO Paving Inc. Toronto, ON Mr. Andrew Pahalan Tel: 416 633-9670	✓	✓	✓	✓
Construction Testing Asphalt Lab Oakville, ON Mr. Peter Lung Tel: 905 469-6352	✓	✓	✓	✓
DBA Engineering Limited Kingston, ON Mr. Mark McClelland Tel: 613 389-1781	✓	✓	✓	✓
DBA Engineering Limited Markham, ON Mr. Andy Burleigh Tel: 905 940-8383	✓	✓	✓	✓
DST Consulting Engineers Inc. Thunder Bay, ON Mr. Scott Tozer Tel: 807 623-2929	✓	✓	✓	✓
Dufferin Construction Ltd. - Mobile 3 Oakville, ON Mr. Waqas Syed Tel: 905 827-5750	✓	✓	✓	✓
Dufferin Construction Ltd. (QC) - Bronte Oakville, ON Mr. Waqas Syed Tel: 905 827-5750	✓	✓	✓	✓
Fermar Construction Limited Rexdale, ON Mr. Ramon Meza Tel: 416 675-3550	✓	✓		✓
Geo-Logic Inc. Peterborough, ON Mr. Wayne Rayfuse Tel: 705 749-3317	✓	✓	✓	✓
Golder Associates Limited Surrey, BC Mrs. Emily Kwok Tel: 604 591-6616	✓	✓	✓	✓

2009 Participants List

Ministry of Transportation
Superpave Aggregate Consensus Property Testing Program

For further information on this program, contact:

Mark Vasavithasan (416) 235-4901 or
Stephen Senior (416) 235-3734

	ASTM D 1252/AASHTO T 304 - Uncompacted Void Content of Fine Aggregate	ASTM D 4219/AASHTO T 176 – Sand Equivalent Value of Fine	ASTM D 5821 – Percent of Fractured Particles in Coarse Aggregate	ASTM D 4791 – Percent Flat Particles, Elongated Particles or Flat & Elongated Particles in Coarse Aggregate
Golder Associates Limited Cambridge, ON Ms. Alana Smith Tel: 519 620-1222	✓	✓	✓	✓
Golder Associates Limited London, ON Mr. Chris Sewell Tel: 519 652-0099	✓	✓	✓	✓
Golder Associates Limited Sudbury, ON Ms. Sylvie LaPorte Tel: 705 524-6861	✓	✓	✓	✓
Golder Associates Limited Whitby, ON Mr. John Watkins Tel: 905 723-2727	✓	✓	✓	✓
Graham Bros. Construction Limited Brampton, ON Mr. Greg Thompson Tel: 905 453-1200	✓	✓	✓	✓
Greenwood Aggregates Orangeville, ON Mr. Andrew Raymond Tel: 519 941-0732	✓	✓	✓	✓
Harold Sutherland Construction Limited Kemble, ON Mr. Roland Leigh Tel: 519 376-3506	✓	✓	✓	✓
Houle Chevrier Engineering Limited Carp, ON Mr. Andrew Chevrier Tel: 613 836-1422	✓	✓	✓	✓
Jacques Whitford Stantec Limited Ottawa, ON Mr. Brian Prevost Tel: 613 738-0708	✓	✓	✓	✓
John D. Paterson & Associates North Bay, ON Mr. Shawn Nelson Tel: 705 472-5331	✓	✓	✓	✓
K.J. Beamish Construction King City, ON Mr. Chad Henderson Tel: 905 833-4666	✓	✓	✓	✓
Karson Kartage & Konstruction Carp, ON Mr. Cameron MacDonald Tel: 613 831-0717	✓	✓	✓	✓
Lafarge Canada Inc. Hamilton, ON Mr. Chris Thomas Tel: 905 522-7735	✓		✓	✓
Lafarge Canada Inc. Dundas, ON Mr. Ryan Smith Tel: 905 527-3671	✓		✓	✓
Landtek Limited Hamilton, ON Mr. Paul Anderson Tel: 905 383-3733	✓	✓	✓	✓
Lavis Contracting Co. Limited Clinton, ON Mr. Allan Gardner Tel: 519 482-3694	✓	✓	✓	✓
LVM-Division of John Emery Geotechnical Toronto, ON Mr. Dawit Amar Tel: 416 213-1060	✓	✓	✓	✓
McAsphalt Engineering Services Toronto, ON Mr. Keith Davidson Tel: 416 282-8181	✓	✓	✓	✓
Mill-Am Corporation - Mobile 890901 Windsor, ON Mr. Abdule Saifan Tel: 519 945-7441	✓	✓	✓	✓
Miller Northwest - Mobile 1 Dryden, ON Mr. Ross Reynolds Tel: 807 223-2844			✓	✓
Miller Northwest - Mobile 87526 Dryden, ON Mr. Ross Reynolds Tel: 807 223-2844	✓			✓
Miller Paving Limited - Markham Gormley, ON Mr. Narayan Hanasoge Tel: 905 726-9518	✓	✓	✓	✓
Miller Paving Limited – Port Colborne Gormley, ON Mr. Narayan Hanasoge Tel: 905 726-9518	✓	✓	✓	✓

2009 Participants List Ministry of Transportation Superpave Aggregate Consensus Property Testing Program For further information on this program, contact: Mark Vasavithasan (416) 235-4901 or Stephen Senior (416) 235-3734	ASTM D 1252/AASHTO T 304 - Uncompacted Void Content of Fine Aggregate	ASTM D 4219/AASHTO T 176 – Sand Equivalent Value of Fine	ASTM D 5821 – Percent of Fractured Particles in Coarse Aggregate	ASTM D 4791 – Percent Flat Particles, Elongated Particles or Flat & Elongated Particles in Coarse Aggregate
Miller Paving Ltd. - Mobile 1084 North Bay, ON Mr. Herb Villneff Tel: 705 472-3312	✓	✓	✓	✓
Miller Paving Ltd. - Mobile 60853 North Bay, ON Mr. Herb Villneff Tel: 705 472-3312	✓	✓	✓	✓
Miller Paving Northern - Mobile 1254 North Bay, ON Mr. Herb Villneff Tel: 705 472-3312	✓	✓	✓	✓
Miller Paving Northern – Mobile 50612 North Bay, ON Mr. Herb Villneff Tel: 705 472-3312	✓	✓	✓	✓
Miller Paving Northern - Mobile 60889 North Bay, ON Mr. Herb Villneff Tel: 705 472-3312	✓	✓	✓	✓
Miller Paving Northern - Mobile 8661 North Bay, ON Mr. Herb Villneff Tel: 705 472-3312			✓	✓
Ministry of Transportation Downsview, ON Mr. Stephen Senior Tel: 416 235-3734	✓	✓	✓	✓
Peto MacCallum Limited Hamilton, ON Mr. Everett Truax Tel: 905 561-2231	✓	✓	✓	✓
Peto MacCallum Limited Kitchener, ON Mr. Tony Smith Tel: 519 893-7500	✓	✓	✓	✓
Peto MacCallum Limited Toronto, ON Mr. Alnoor Nathoo Tel: 416 785-5110	✓	✓	✓	✓
Pioneer Construction Inc. Sault Ste. Marie, ON Mrs. Shelley Geiling Tel: 705 541-2280	✓	✓	✓	✓
Pioneer Construction Inc. Thunder Bay, ON Mrs. Shelley Geiling Tel: 705 541-2280	✓	✓	✓	✓
Pioneer Construction Inc. Copper Cliff, ON Mr. David Pilkey Tel: 705 693-1363	✓	✓	✓	✓
R. W. Tomlinson Limited Ottawa , ON Mr. Bert Hendriks Tel: 613 822-1867	✓	✓	✓	✓
R. W. Tomlinson Limited – Mobile No. 1 Gloucester, ON Mr. Bert Hendriks Tel: 613 822-1867			✓	✓
St Lawrence Testing & Inspection Co. Ltd. Cornwall, ON Mr. Gib McIntee Tel: 613 938-2521	✓	✓	✓	✓
Steed and Evans Ltd. Heidelberg, ON Mr. Richard Marco Tel: 519 699-4646	✓		✓	✓
Terraprobe Testing Limited Brampton, ON Mr. Chris Elvidge Tel: 905 796-2650	✓	✓	✓	✓
The Miller Group Materials Research Lab Gormley, ON Mr. Narayan Hanasoge Tel: 905 726-9518	✓	✓	✓	✓
Thunder Bay Testing and Engineering Ltd. Thunder Bay, ON Mr. Tim Fummerton Tel: 807 624-5162	✓	✓	✓	✓
Trow Associates Inc. Brampton, ON Dr. Salman Bhutta Tel: 905 793-9800	✓	✓	✓	✓
Trow Associates Inc. Ottawa, ON Mr. Ismail Taki Tel: 613 225-9940	✓	✓	✓	✓
Trow Associates Inc. Sudbury, ON Mr. Rob Ferguson Tel: 705 674-9681	✓	✓	✓	✓

Appendix C: Multi-Laboratory Precision

Test 1	2006		2007		2008		2009		ASTM C117
WP 75 µm	1.06	2.06	1.07	2.07	1.08	2.08	1.09	2.09	
Mean	1.36	1.46	0.80	0.80	0.39	0.39	1.97	1.90	<1.5
1S	0.27	0.28	0.17	0.15	0.20	0.20	0.24	0.25	0.22
D2S	0.77	0.81	0.47	0.42	0.56	0.57	0.67	0.71	0.62
n/Outliers	200/8		199/6		210/3		214/4		

Test 2	2006		2007		2008		2009		ASTM C136[A]
P 19.0 mm	1.06	2.06	1.07	2.07	1.08	2.08	1.09	2.09	
Mean	95.6	95.6	93.8	92.8	97.8	97.8	98.9	98.9	100 - 95
1S	0.8	0.7	1.4	1.7	0.5	0.6	0.4	0.3	0.35
D2S	2.4	2.1	4.0	4.9	1.4	1.6	1.0	0.9	1.0
n/Outliers	208/0		203/2		210/3		212/6		

Test 3	2006		2007		2008		2009		ASTM C136[A]
P 16.0 mm	1.06	2.06	1.07	2.07	1.08	2.08	1.09	2.09	
Mean	88.2	88.1	77.7	74.6	91.1	90.7	94.8	94.8	95 - 85
1S	1.1	0.9	2.0	3.4	0.9	0.9	0.6	0.6	1.37
D2S	3.2	2.5	5.6	9.7	2.5	2.6	1.8	1.8	3.9
n/Outliers	200/8		203/2		208/5		215/3		

Test 4	2006		2007		2008		2009		ASTM C136[A]
P 13.2 mm	1.06	2.06	1.07	2.07	1.08	2.08	1.09	2.09	
Mean	81.5	81.3	60.8	57.1	82.9	82.3	90.7	90.8	95 - 85
1S	1.3	1.0	2.4	4.1	1.1	1.3	0.7	0.7	1.37
D2S	3.6	2.8	6.8	11.6	3.2	3.7	2.0	1.9	3.9
n/Outliers	207/1		202/3		210/3		210/8		

Test 5	2006		2007		2008		2009		ASTM C136[A]
P 9.5 mm	1.06	2.06	1.07	2.07	1.08	2.08	1.09	2.09	
Mean	70.5	70.5	33.3	30.9	69.0	68.1	83.7	83.9	85 - 80
1S	1.4	1.1	2.2	3.1	1.2	1.4	0.8	0.7	1.92
D2S	4.0	3.2	6.2	8.8	3.4	4.1	2.4	2.0	5.4
n/Outliers	205/3		200/5		210/3		208/10		

Test 6	2006		2007		2008		2009		ASTM C136[A]
P 4.75 mm	1.06	2.06	1.07	2.07	1.08	2.08	1.09	2.09	
Mean	55.5	55.5	4.5	4.3	51.1	50.2	72.3	72.6	80 – 60
1S	1.3	1.0	0.6	0.7	1.2	1.4	0.8	0.8	2.82
D2S	3.6	2.8	1.7	1.9	3.4	4.1	2.4	2.2	8.0
n/Outliers	204/4		200/5		206/7		208/10		

Test 8	2006		2007		2008		2009		ASTM C131	
L. A	1.06	2.06	1.07	2.07	1.08	2.08	1.09	2.09	C of V	σ^*
Mean	18.47	18.15	23.4	23.5	22.4	22.1	25.8	26.2	10-45	26.0
1S	1.51	1.94	0.71	1.12	1.27	1.11	1.37	1.71	4.5%	1.17
D2S	4.26	5.50	2.00	3.18	3.61	3.14	3.88	4.83	12.7%	3.31
n/Outliers	10/0		9/1		10/1		10/2			

A – AMRL reports percent passing inch series equivalent sieves.

σ^* - Calculated from Coefficient of Variation Precision Statement (Coefficient of Variation = Standard Deviation / Mean)

Test 9	2006		2007		2008		2009		ASTM C127	
RD (O.D.)	1.06	2.06	1.07	2.07	1.08	2.08	1.09	2.09		
Mean	2.669	2.669	2.683	2.684	2.657	2.657	2.690	2.691		
1S	0.005	0.006	0.007	0.006	0.007	0.008	0.005	0.006	0.013	
D2S	0.014	0.017	0.020	0.017	0.020	0.023	0.014	0.017	0.038	
n/Outliers	91/10		90/6		94/3		97/9			

Test 10	2006		2007		2008		2009		ASTM C127-88	
ABS	1.06	2.06	1.07	2.07	1.08	2.08				
Mean	1.840	1.835	0.497	0.494	0.971	0.954	0.393	0.389	< 2%	
1S	0.093	0.081	0.066	0.079	0.089	0.087	0.058	0.063	0.145	
D2S	0.263	0.229	0.187	0.223	0.252	0.246	0.164	0.178	0.41	
n/Outliers	92/9		95/1		95/2		95/11			

Test 11	2006		2007		2008		2009		ASTM C88	
$MgSO_4$	1.06	2.06	1.07	2.07	1.08	2.08	1.09	2.09	C of V	σ^*
Mean	7.5	7.5	3.3	3.2	4.3	4.2	8.9	9.0	9-20%	8.9
1S	2.2	2.1	1.1	1.0	1.4	1.4	2.7	2.0	25%	2.2
D2S	6.4	5.9	3.1	2.8	4.0	4.0	7.6	5.6	71%	6.3
n/Outliers	36/1		36/1		36/0		39/2			

Test 12	2006		2007		2008		2009		MTO Workshop	
% Crush	1.06	2.06	1.07	2.07	1.08	2.08	1.09	2.09		
Mean	74.3	74.2	65.2	66.8	63.1	63.6	56.9	57.2	50 - 75	
1S	4.2	4.3	6.4	6.2	3.8	3.7	6.9	7.1	6.0%	
D2S	11.8	12.3	18.1	17.7	10.8	10.5	19.5	20.0	16.9%	
n/Outliers	196/12		201/4		202/11		215/3			

Test 13	2006		2007		2008		2009		MTO LS-608	
% F & E	1.06	2.06	1.07	2.07	1.08	2.08	1.09	2.09	C of V	σ
Mean	9.7	8.9	15.3	15.5	3.3	3.5	5.5	5.2		5.4
1S	3.4	3.5	4.4	4.3	1.6	1.8	2.3	2.1	41%	2.2
D2S	9.7	10.0	12.4	12.2	4.5	5.1	6.5	6.0	116%	6.2
n/Outliers	163/6		164/2		170/6		194/13			

Test 14	2006		2007		2008		2009		ASTM	
PN Conc.	1.06	2.06	1.07	2.07	1.08	2.08	1.09	2.09		
Mean	122.7	120.9	113.6	112.7	113.4	115.8	120.2	119.9	No ASTM	
1S	7.9	7.7	5.7	6.7	5.4	8.0	7.6	6.0	Standard for this	
D2S	22.3	21.8	16.0	19.1	15.3	22.6	21.5	17.0	Test.	
n/Outliers	25/0		23/1		25/3		25/2			

Test 16	2006		2007		2008		2009		MTO LS-618	
MDA, CA	1.06	2.06	1.07	2.07	1.08	2.08	1.09	2.09	C of V	σ
Mean	5.6	5.4	12.2	12.4	14.7	14.7	13.0	13.2	5-20%	13.1
1S	0.38	0.35	0.70	0.66	0.77	0.85	0.94	1.08	5.6%	0.73
D2S	1.08	0.98	1.99	1.88	2.17	2.41	2.66	3.06	15.8%	2.08
n/Outliers	58/3		60/3		65/4		66/4			

Test 17	2006		2007		2008		2009		MTO LS-614	
Freeze-thaw	1.06	2.06	1.07	2.07	1.08	2.08	1.09	2.09	C of V	σ
Mean	12.68	13.22	4.53	4.28	7.62	7.68	12.12	11.79	5-18%	11.95
1S	1.38	2.00	1.00	0.85	1.59	1.67	2.16	1.88	21%	2.51
D2S	3.91	5.67	2.82	2.40	4.51	4.74	6.11	5.32	59%	7.10
n/Outliers	44/4		46/3		49/2		51/4			

A – AMRL reports percent passing inch series equivalent sieves.

σ^* - Calculated from Coefficient of Variation Precision Statement (Coefficient of Variation = Standard Deviation / Mean)

Test 20 P 2.36 mm	2006 3.06	 4.06	2007 3.07	 4.07	2008 3.08	 4.08	2009 3.09	 4.09	ASTM C136^A
Mean	45.4	45.3	92.9	93.0	40.9	40.4	63.4	63.5	95 - 60
1S	1.7	1.6	0.9	0.7	1.7	1.6	1.3	1.6	0.77
D2S	4.8	4.5	2.6	1.9	4.7	4.6	3.7	4.5	2.2
n/Outliers	202/6		201/4		207/6		202/16		

Test 21 P 1.18 mm	2006 3.06	 4.06	2007 3.07	 4.07	2008 3.08	 4.08	2009 3.09	 4.09	ASTM C136^A
Mean	36.5	36.5	68.1	68.4	33.3	32.9	52.5	52.6	60 - 20
1S	2.1	1.9	1.9	1.7	1.8	1.8	1.8	2.1	1.41
D2S	5.9	5.5	5.5	4.7	5.1	5.1	5.1	5.9	4.0
n/Outliers	206/2		202/3		210/3		203/15		

Test 22 P 600 μm	2006 3.06	 4.06	2007 3.07	 4.07	2008 3.08	 4.08	2009 3.09	 4.09	ASTM C136^A
Mean	28.2	28.2	33.2	33.5	26.5	26.3	37.9	37.8	60 - 20
1S	1.8	1.9	2.1	1.9	1.6	1.6	2.1	2.3	1.41
D2S	5.2	5.3	6.0	5.4	4.7	4.6	5.9	6.6	4.0
n/Outliers	207/1		203/2		209/4		204/14		

Test 23 P 300 μm	2006 3.06	 4.06	2007 3.07	 4.07	2008 3.08	 4.08	2009 3.09	 4.09	ASTM C136^A
Mean	19.0	19.1	9.5	9.4	18.4	18.2	19.6	19.7	20 - 15
1S	1.3	1.4	1.1	0.7	1.1	1.1	1.3	1.7	1.10
D2S	3.6	3.9	3.2	2.1	3.1	3.2	3.8	4.8	3.1
n/Outliers	207/1		197/8		206/7		206/12		

Test 24 P 150 μm	2006 3.06	 4.06	2007 3.07	 4.07	2008 3.08	 4.08	2009 3.09	 4.09	ASTM C136^A
Mean	12.0	12.2	2.7	2.6	12.0	12.0	9.7	9.8	10 - 2
1S	0.8	0.8	0.4	0.4	0.7	0.7	0.7	0.9	0.65
D2S	2.3	2.4	1.2	1.0	1.9	2.0	2.1	2.5	1.8
n/Outliers	205/3		202/3		206/7		209/9		

Test 25 P 75 μm	2006 3.06	 4.06	2007 3.07	 4.07	2008 3.08	 4.08	2009 3.09	 4.09	ASTM C136^A
Mean	7.7	7.8	1.7	1.6	8.2	8.2	5.9	6.0	10 - 2
1S	0.6	0.6	0.3	0.3	0.5	0.5	0.4	0.4	0.65
D2S	1.6	1.6	0.9	0.9	1.4	1.5	1.2	1.3	1.8
n/Outliers	202/6		199/6		205/8		203/15		

Test 27 RD (O.D.)	2006 3.06	 4.06	2007 3.07	 4.07	2008 3.08	 4.08	2009 3.09	 4.09	ASTM C128
Mean	2.665	2.615	2.611	2.601	2.659	2.660	2.686	2.687	
1S	0.015	0.038	0.011	0.013	0.011	0.009	0.009	0.010	0.023
D2S	0.042	0.107	0.031	0.037	0.031	0.025	0.025	0.028	0.066
n/Outliers	90/10		83/10		89/5		88/14		

Test 28 ABS	2006 3.06	 4.06	2007 3.07	 4.07	2008 3.08	 4.08	2009 3.09	 4.09	ASTM C128
Mean	0.746	1.502	1.849	1.993	0.644	0.642	0.940	0.940	< 1.0%
1S	0.13	0.49	0.16	0.14	0.11	0.12	0.134	0.130	0.23
D2S	0.37	1.38	0.46	0.39	0.32	0.34	0.38	0.37	0.66
n/Outliers	88/12		80/13		91/3		97/5		

A – AMRL reports percent passing inch series equivalent sieves.

σ^{*} - Calculated from Coefficient of Variation Precision Statement (Coefficient of Variation = Standard Deviation / Mean)

Test 29	2006		2007		2008		2009		ASTM C88
$MgSO_4$	3.06	4.06	3.07	4.07	3.08	4.08	3.09	4.09	
Mean	11.7	11.7	14.8	15.3	This Test is Discontinued from the Program		This Test is Discontinued from the Program	This Test is Discontinued from the Program	ASTM precision Statements for Coarse Aggregate only
1S	3.4	3.2	4.7	4.3					
D2S	9.6	9.0	13.2	12.2					
n/Outliers	31/0		32/0						

Test 30	2006		2007		2008		2009		MTO LS-621	
% ACP	1.06	2.06	1.07	2.07	1.08	2.08	1.09	2.09	C of V	σ
Mean	39.7	39.9	29.5	29.4	36.5	37.1	27.3	27.2	25-45%	27.2
1S	4.7	4.7	4.8	4.7	5.9	6.0	4.7	3.8	9.6%	2.6
D2S	13.2	13.3	13.7	13.3	16.8	17.00	13.2	10.7	27.0%	7.4
n/Outliers	206/1		203/1		210/3		203/14			

Test 31	2006		2007		2008		2009		MTO LS-623
MWD	3.06	4.06	1.07	2.07	3.08	4.08	3.09	4.09	
Mean	2.271	2.272	2.382	2.385	2.320	2.317	2.176	2.180	
1S	0.031	0.030	0.039	0.032	0.039	0.046	0.029	0.036	0.030
D2S	0.088	0.085	0.110	0.090	0.110	0.130	0.082	0.102	0.085
n/Outliers	147/4		145/2		151/1		150/8		

Test 32	2006		2007		2008		2009		MTO LS-623
MDD	3.06	4.06	1.07	2.07	3.08	4.08	3.09	4.09	
Mean	2.093	2.095	2.223	2.226	2.151	2.151	1.979	1.982	
1S	0.038	0.041	0.035	0.034	0.041	0.047	0.037	0.039	0.033
D2S	0.107	0.116	0.099	0.096	0.116	0.133	0.105	0.110	0.093
n/Outliers	149/2		147/0		151/1		155/3		

Test 33	2006		2007		2008		2009		MTO LS-623
OMC	3.06	4.06	1.07	2.07	3.08	4.08	3.09	4.09	
Mean	8.55	8.48	7.37	7.34	7.95	7.93	10.04	10.04	
1S	0.50	0.61	0.32	0.32	0.45	0.39	0.44	0.48	0.41
D2S	1.41	1.72	0.90	0.90	1.27	1.12	1.25	1.37	1.15
n/Outliers	147/4		144/3		146/6		153/5		

Test 34	2006		2007		2008		2009		MTO LS-619	
MDA, FA3	3.06	4.06	3.07	4.07	3.08	4.08	3.09	4.09	C of V	σ
Mean	11.6	11.7	16.8	16.7	11.9	11.8	13.2	13.2	7-30%	13.2
1S	0.9	0.8	1.1	0.8	0.9	0.8	1.1	1.2	8.7%	1.1
D2S	2.7	2.4	3.1	2.4	2.5	2.2	3.0	3.4	24.6%	3.2
n/Outliers	60/2		58/5		63/6		68/2			

Test 40	2006		2007		2008		2009		MTO LS-702
P 2.0 mm	5.06	6.06	5.07	6.07	5.08	6.08	5.09	6.09	
Mean	100.0	99.9	99.9	99.9	100.0	100.0	99.9	99.9	No MTO precision statements for this test
1S									
D2S									
n/Outliers	68/0		66/0		70/0		71/0		

Test 41	2006		2007		2008		2009		MTO LS-702
P 425 µm	5.06	6.06	5.07	6.07	5.08	6.08	5.09	6.09	
Mean	96.9	96.9	97.0	97.1	99.8	99.8	97.2	97.1	No MTO precision statements for this test
1S	0.5	0.5	0.6	0.5	0.1	0.1	0.5	0.6	
D2S	1.6	1.4	1.6	1.5	0.4	0.4	1.5	1.7	
n/Outliers	61/7		61/5		66/4		69/2		

A – AMRL reports percent passing inch series equivalent sieves.

σ^* - Calculated from Coefficient of Variation Precision Statement (Coefficient of Variation = Standard Deviation / Mean)

Test 42 P 75 µm	2006 5.06	 6.06	2007 5.07	 6.07	2008 5.08	 6.08	2009 5.09	 6.09	MTO LS-702
Mean	91.7	91.5	91.6	91.7	99.1	99.1	91.8	91.4	No MTO
1S	0.8	0.8	0.8	0.8	0.3	0.3	1.0	0.9	precision
D2S	2.3	2.2	2.3	2.2	1.0	1.0	2.9	2.6	statements for
n/Outliers	60/8		62/4		66/4		66/5		this test

Test 43 P 20 µm	2006 5.06	 6.06	2007 5.07	 6.07	2008 5.08	 6.08	2009 5.09	 6.09	MTO LS-702
Mean	78.1	78.9	78.7	78.7	80.4	80.1	79.1	78.5	No MTO
1S	6.0	4.5	3.5	4.1	4.6	4.5	3.9	3.5	precision
D2S	17.1	12.8	9.8	11.5	12.9	12.7	11.0	10.0	statements for
n/Outliers	61/7		63/3		69/1		71/0		this test

Test 44 P 5 µm	2006 5.06	 6.06	2007 5.07	 6.07	2008 5.08	 6.08	2009 5.09	 6.09	MTO LS-702
Mean	59.2	58.9	59.2	59.4	44.8	44.2	58.9	58.8	No MTO
1S	2.7	2.9	2.8	3.2	3.8	3.0	3.6	3.5	precision
D2S	7.8	8.1	8.0	9.1	10.8	8.6	10.1	9.9	statements for
n/Outliers	58/10		60/6		66/4		69/2		this test

Test 45 P 2 µm	2006 5.06	 6.06	2007 5.07	 6.07	2008 5.08	 6.08	2009 5.09	 6.09	MTO LS-702
Mean	44.4	44.6	44.0	44.6	29.9	29.4	44.4	44.0	No MTO
1S	3.1	3.1	3.4	3.3	3.3	3.2	2.9	3.1	precision
D2S	8.9	8.8	9.7	9.5	9.5	9.0	8.3	8.8	statements for
n/Outliers	61/7		63/3		67/3		69/2		this test

Test 46 L. L	2006 5.06	 6.06	2007 5.07	 6.07	2008 5.08	 6.08	2009 5.09	 6.09	ASTM D4318
Mean	37.1	36.9	37.0	37.2	32.6	32.7	36.9	36.7	33.3
1S	1.9	1.9	1.6	1.5	1.4	1.4	1.3	1.7	0.8
D2S	5.3	5.4	4.5	4.2	3.9	4.1	3.7	4.8	2
n/Outliers	77/1		76/3		77/3		79/6		

Test 47 P. L	2006 5.06	 6.06	2007 5.07	 6.07	2008 5.08	 6.08	2009 5.09	 6.09	ASTM D4318
Mean	19.2	19.0	18.9	19.1	19.0	18.9	18.9	18.8	19.9
1S	1.6	1.6	1.3	0.9	1.1	1.0	1.2	1.3	1.3
D2S	4.4	4.4	3.8	2.7	3.1	2.9	3.5	3.7	4
n/Outliers	74/4		77/2		76/4		81/4		

Test 48 P. I	2006 5.06	 6.06	2007 5.07	 6.07	2008 5.08	 6.08	2009 5.09	 6.09	ASTM D4318
Mean	17.9	18.0	18.1	18.1	13.8	13.8	17.9	17.8	13.4
1S	1.7	1.9	1.3	1.4	1.8	1.5	1.9	2.0	1.6
D2S	4.7	5.6	3.8	4.0	5.2	4.3	5.5	5.8	4
n/Outliers	75/3		70/9		75/5		84/1		

Test 49 SG of Soils	2006 5.06	 6.06	2007 5.07	 6.07	2008 5.08	 6.08	2009 5.09	 6.09	AASHTO T 100
Mean	2.733	2.730	2.731	2.732	2.719	2.724	2.734	2.735	
1S	0.030	0.031	0.027	0.026	0.029	0.023	0.031	0.029	0.04
D2S	0.085	0.088	0.076	0.074	0.082	0.065	0.088	0.082	0.11
n/Outliers	52/4		44/11		54/4		54/6		

A – AMRL reports percent passing inch series equivalent sieves.

σ^{*} - Calculated from Coefficient of Variation Precision Statement (Coefficient of Variation = Standard Deviation / Mean)

Test 95	2006		2007		2008		2009		ASTM C1252
UC Void	3.06	4.06	1.07	2.07	1.08	2.08	1.09	2.09	
Mean	43.13	42.06	41.32	41.21	41.86	41.91	41.97	41.92	ASTM C1252[A]
1S	0.68	1.08	0.70	0.52	0.57	0.54	0.68	0.56	0.33%
D2S	1.93	3.06	1.97	1.48	1.63	1.52	1.92	1.58	0.93%
n/Outliers	50/5		54/3		52/6		59/4		

Test 96	2006		2007		2008		2009		ASTM D2419
SE Value	3.06	4.06	1.07	2.07	1.08	2.08	1.09	2.09	
Mean	56.4	55.9	90.6	90.8	35.5	35.2	69.4	68.7	< 80
1S	5.76	5.91	3.49	3.75	4.01	3.95	5.12	5.33	8.0
D2S	16.30	16.72	9.89	10.63	11.34	11.19	14.48	15.09	22.6
n/Outliers	53/0		54/0		56/0		58/1		

Test 97	2006		2007		2008		2009		ASTM D5821
% Fractured	1.06	2.06	1.07	2.07	1.08	2.08	1.09	2.09	
Mean	75.7	76.1	67.0	67.8	63.6	64.4	58.3	58.8	76.0%
1S	3.9	4.7	3.7	4.6	3.9	3.7	6.8	6.8	5.2%
D2S	11.21	13.31	10.4	12.9	11.1	10.5	19.4	19.3	14.7%
n/Outliers	54/3		54/4		58/2		61/3		

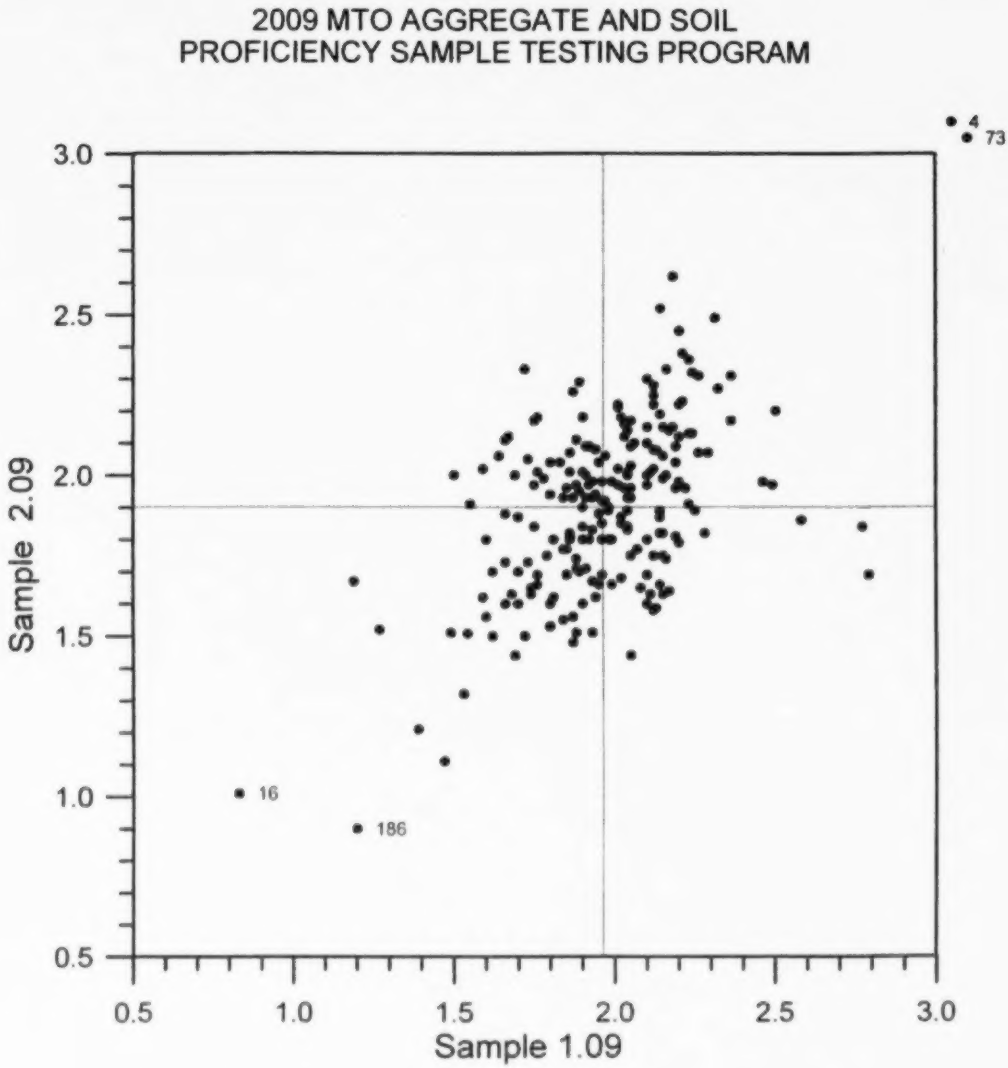
Test 99	2006		2007		2008		2009		ASTM D4791
% F & E	1.06	2.06	1.07	2.07	1.08	2.08	1.09	2.09	
Mean	2.68	2.25	4.42	4.53	0.48	0.56	1.10	1.02	No ASTM
1S	1.36	1.16	1.86	1.99	0.35	0.31	0.68	0.67	precision
D2S	3.86	3.27	5.27	5.63	1.00	0.89	1.92	1.90	statements for
n/Outliers	55/1		55/2		56/4		60/6		this test

Test 123	2006		2007		2008		2009		ASTM C1260
Mortar Bar	1.06	2.06	1.07	2.07	1.08	2.08	1.09	2.09	
Mean	Not Conducted		Not Conducted		Not Conducted		Not Conducted		Expansion >0.1%
1S									15.2%
D2S									43 %
n/Outliers									

A – AMRL reports percent passing inch series equivalent sieves.

σ^{*} - Calculated from Coefficient of Variation Precision Statement (Coefficient of Variation = Standard Deviation / Mean)

Appendix D1: Scatter Diagrams



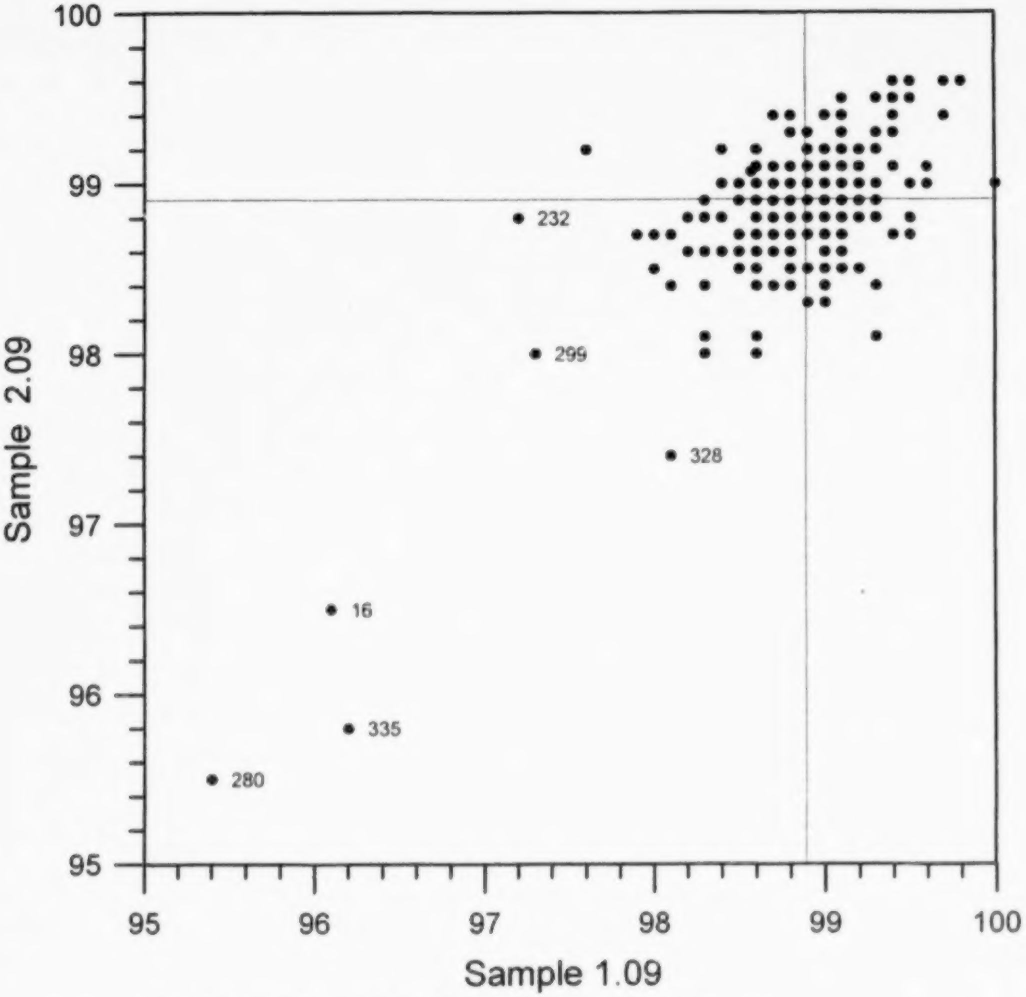
Test 1: Wash Pass 75 um

	Mat 1	Mat 2
Mean	1.969	1.901
Median	1.990	1.865
Std Dev	0.238	0.252

n = 214

Labs Eliminated: 4; 16; 73; 186

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



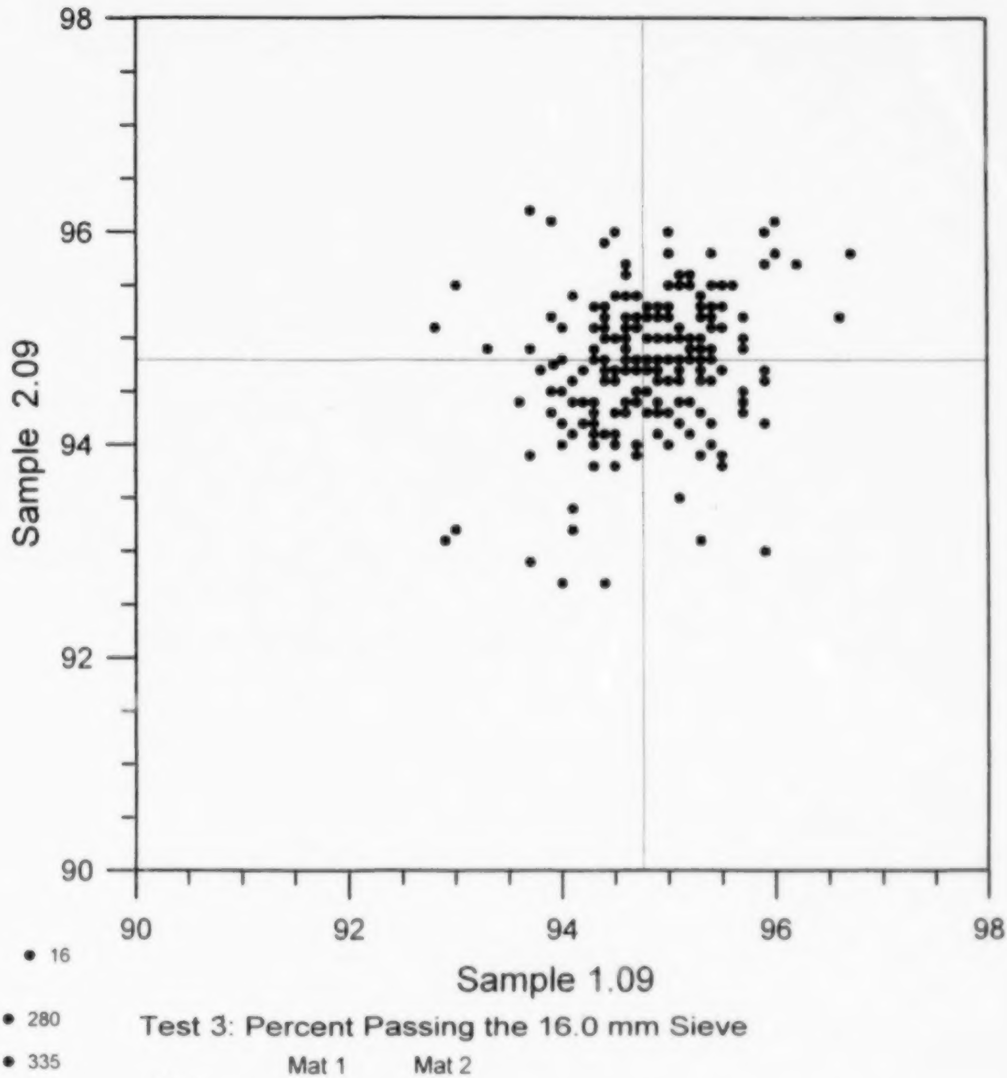
Test 2: Percent Passing the 19.0 mm Sieve

	Mat 1	Mat 2
Mean	98.867	98.888
Median	98.800	98.800
Std Dev	0.364	0.322

n = 212

Lab Eliminated: 16; 232; 280; 299; 328; 335

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



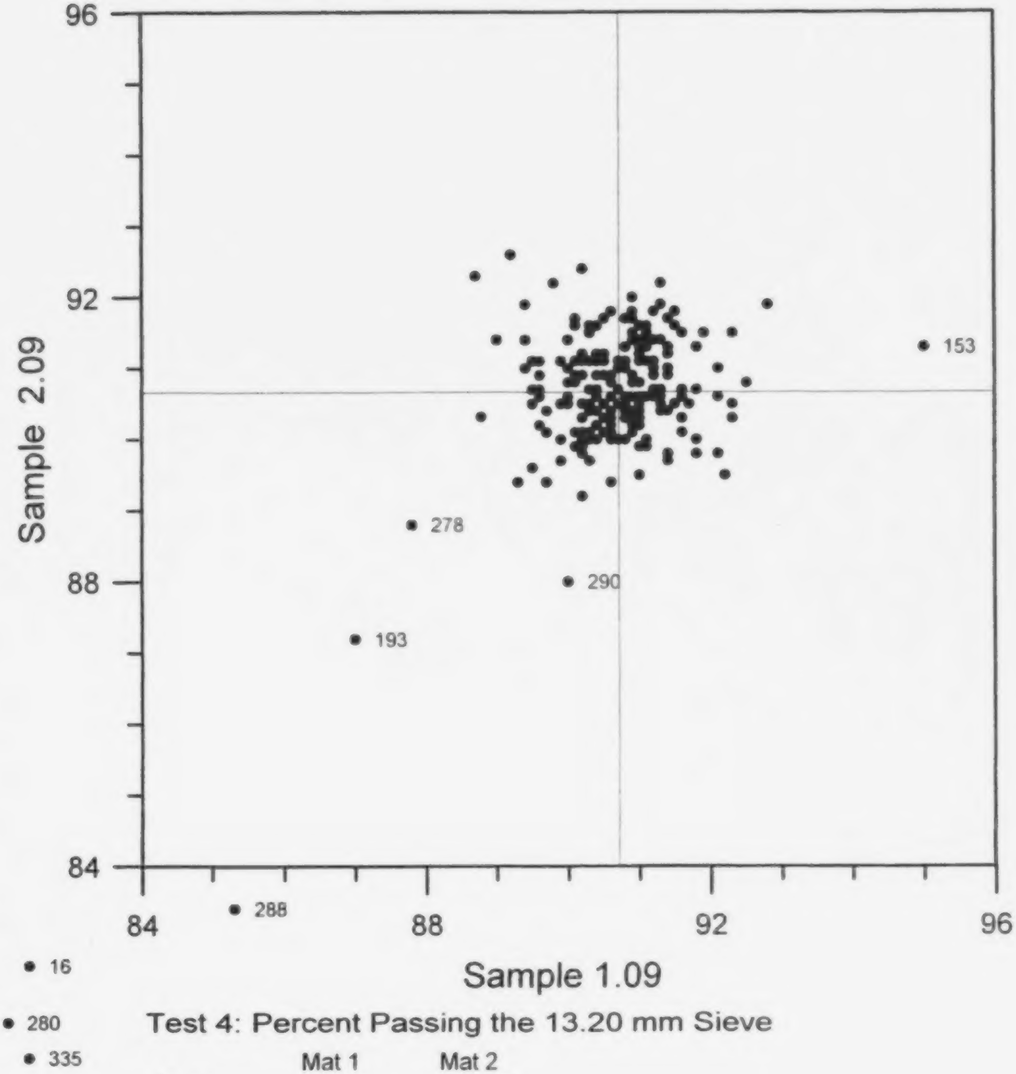
Test 3: Percent Passing the 16.0 mm Sieve

	Mat 1	Mat 2
Mean	94.814	94.771
Median	94.750	94.450
Std Dev	0.632	0.651

n = 215

Lab Eliminated: 16; 280; 335

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



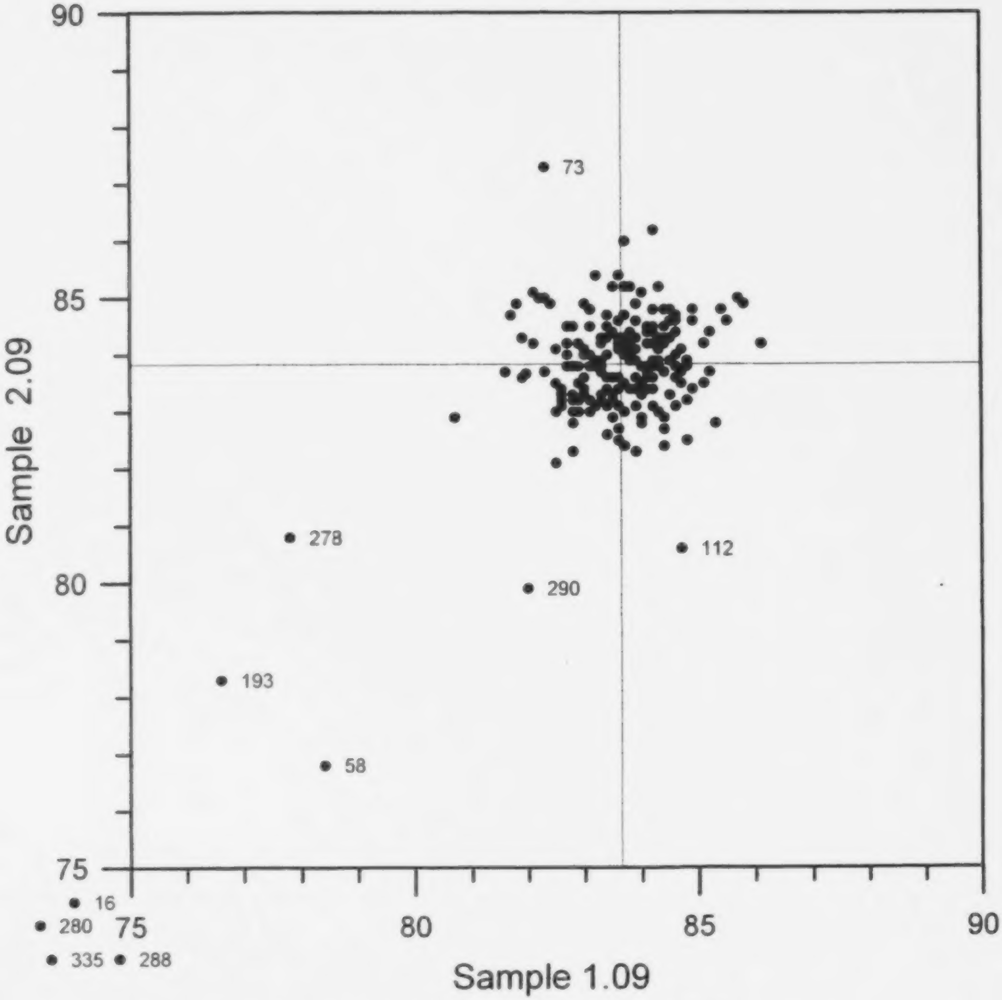
Test 4: Percent Passing the 13.20 mm Sieve

	Mat 1	Mat 2
Mean	90.702	90.760
Median	90.750	90.900
Std Dev	0.700	0.657

n = 210

Lab Eliminated: 16; 153; 193; 278; 280; 288; 290; 335

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



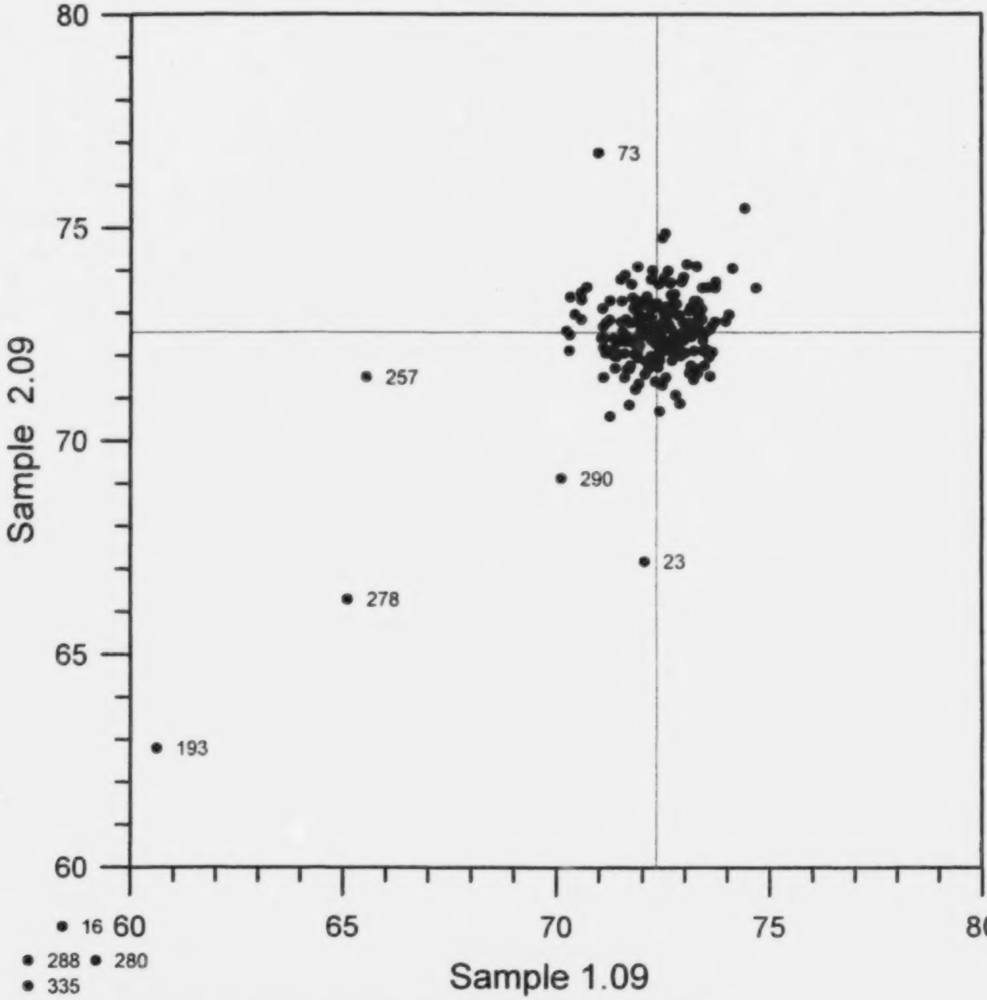
Test 5: Percent Passing the 9.5 mm Sieve

	Mat 1	Mat 2
Mean	83.672	83.871
Median	83.400	84.150
Std Dev	0.854	0.711

n = 208

Labs Eliminated: 16; 58; 73; 112; 193; 278; 280; 288; 290; 335,

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



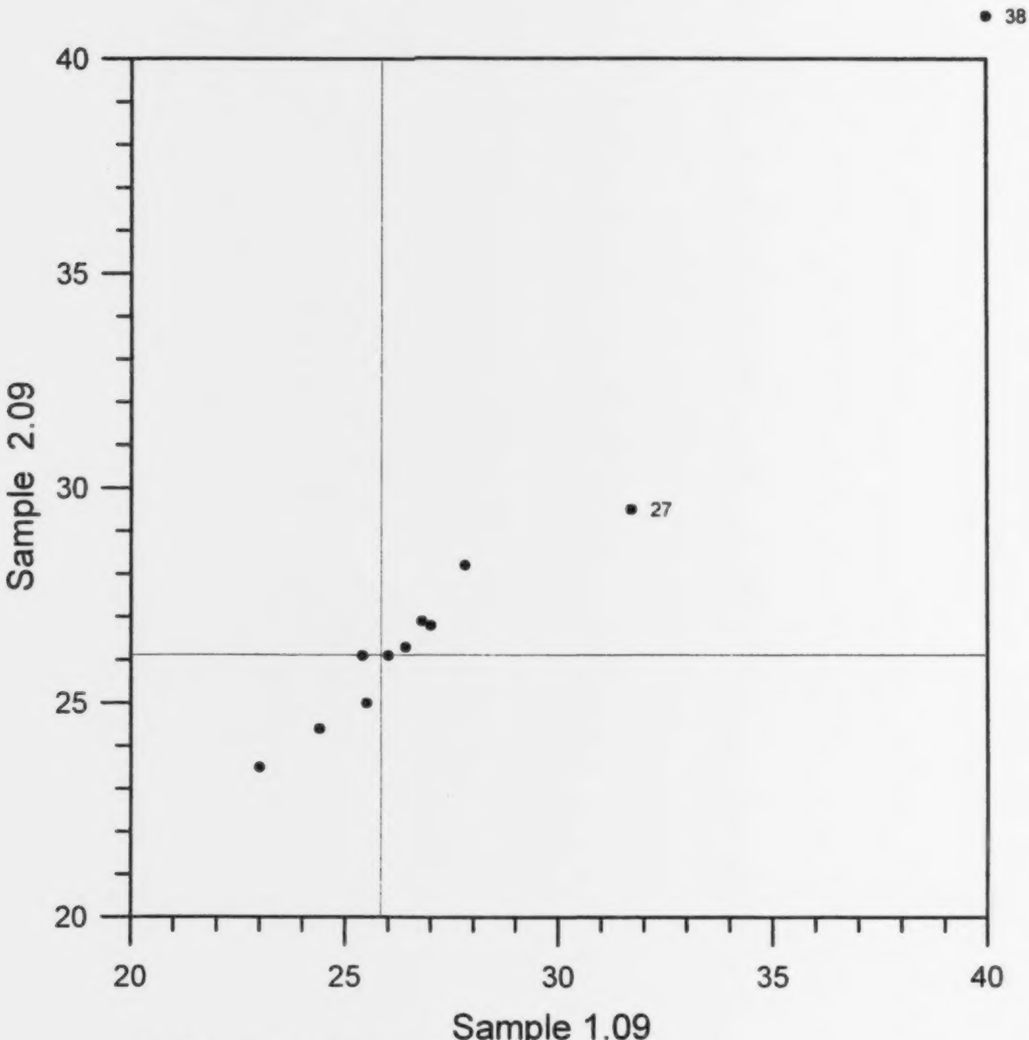
Test 6: Percent Passing the 4.75 mm Sieve

	Mat 1	Mat 2
Mean	72.327	72.633
Median	72.450	73.025
Std Dev	0.835	0.764

n = 208

Lab Eliminated: 16; 23; 73; 193; 257; 278; 280; 288; 290; 335

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



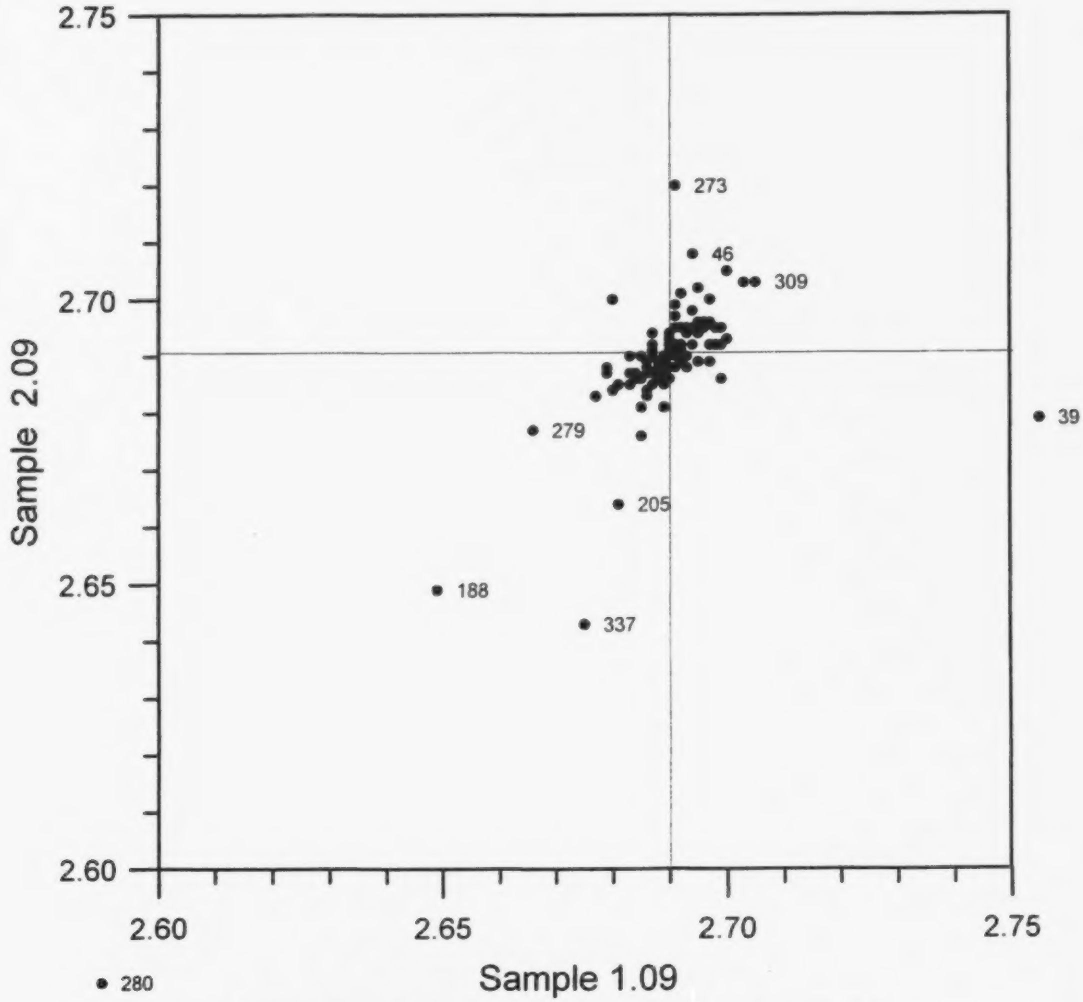
Test 8: Los Angeles Abrasion Loss, %

	Mat 1	Mat 2
Mean	25.780	26.164
Median	25.400	25.850
Std Dev	1.373	1.708

n = 10

Labs Eliminated: 27; 38

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



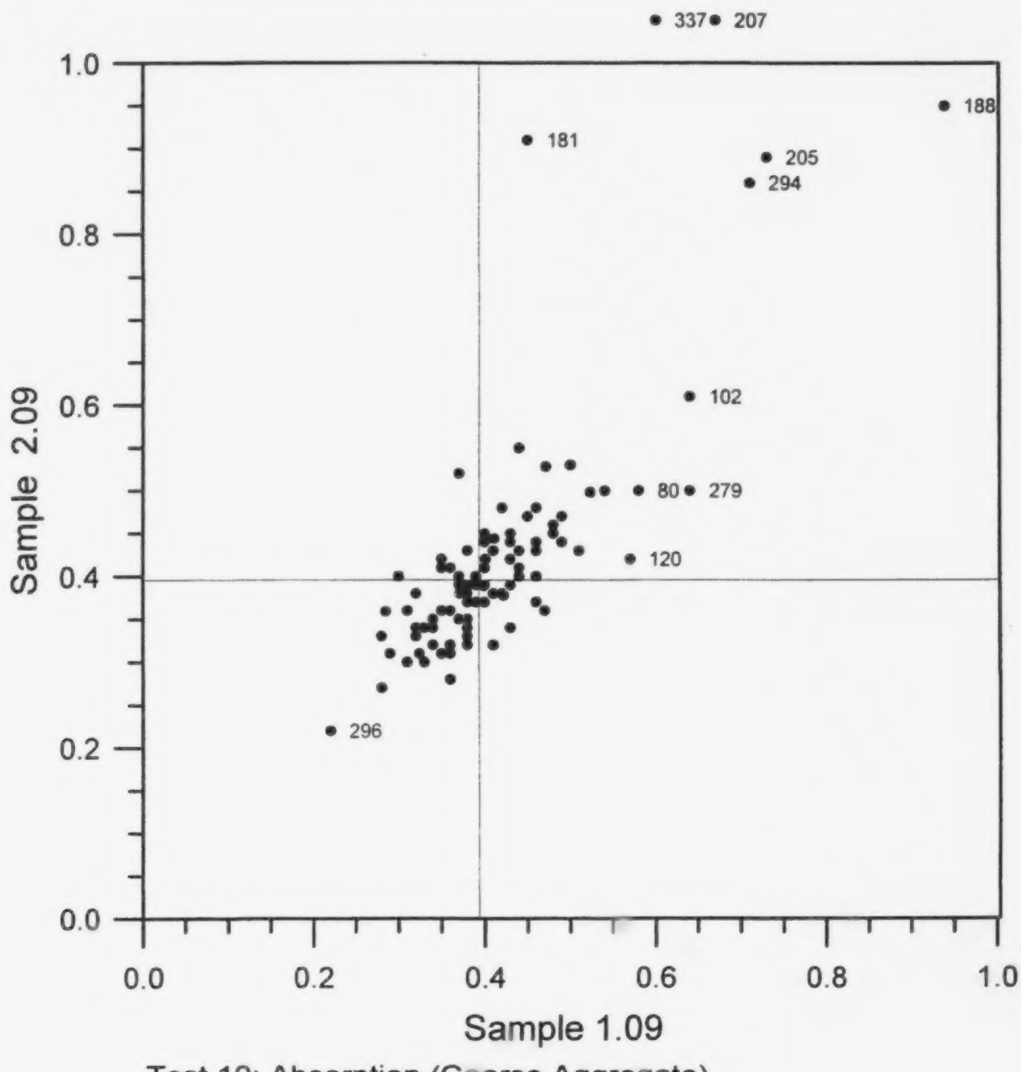
Test 9: Relative Density, (Coarse Aggregate - Bulk)

	Mat 1	Mat 2
Mean	2.690	2.691
Median	2.690	2.691
Std Dev	0.005	0.006

n = 97

Labs Eliminated: 39; 46; 188; 205; 273; 279; 280; 309; 337

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



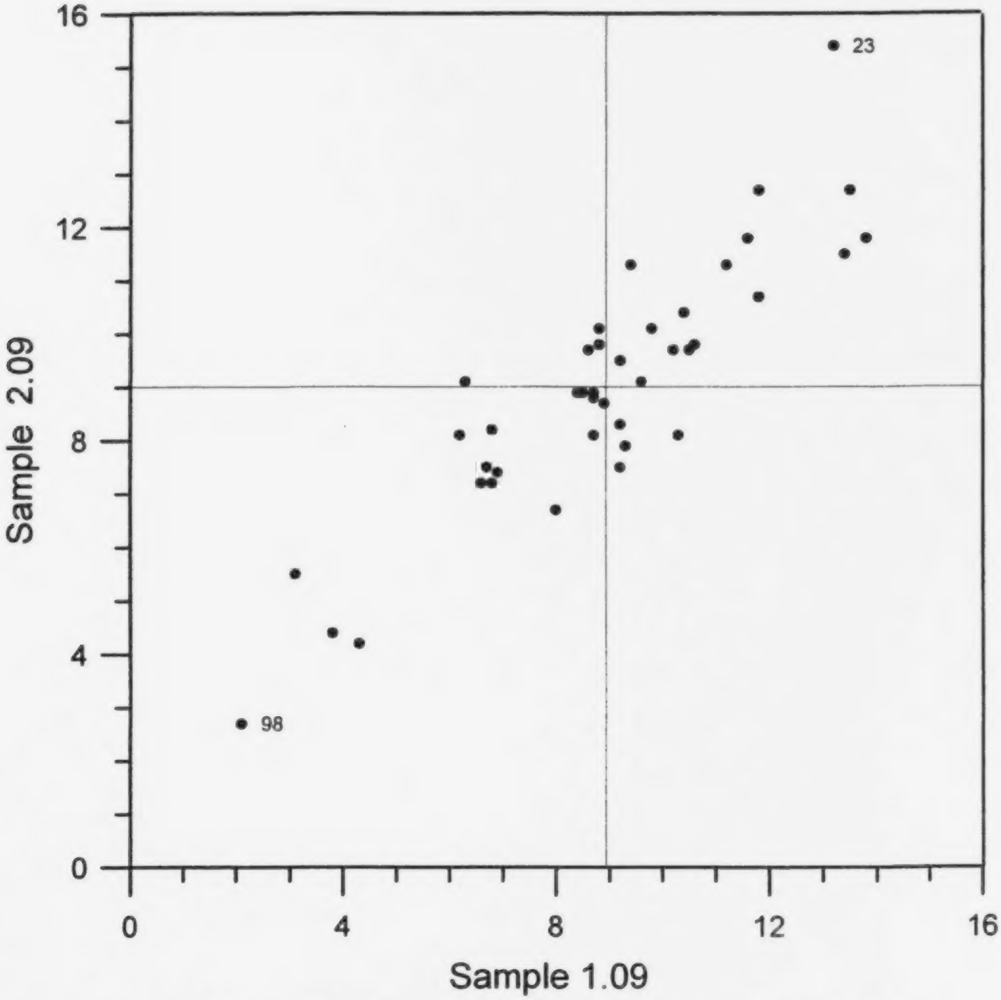
Test 10: Absorption (Coarse Aggregate)

	Mat 1	Mat 2
Mean	0.393	0.389
Median	0.410	0.410
Std Dev	0.058	0.063

n = 95

Labs Eliminated: 80; 102; 120; 181; 188; 205; 207; 279; 294; 296; 337

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



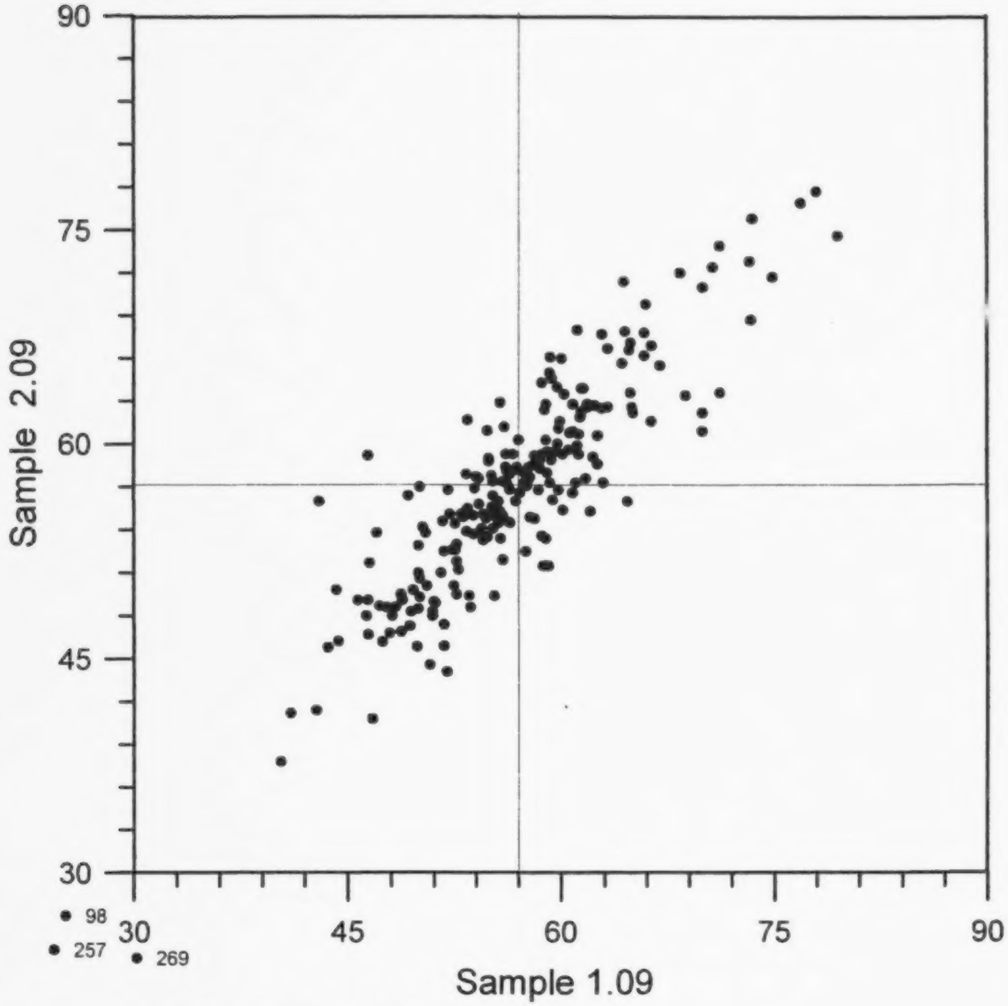
Test 11: MgSO4 Soundness (Coarse Aggregate), % Loss

	Mat 1	Mat 2
Mean	8.871	9.008
Median	8.450	8.450
Std Dev	2.702	1.989

n = 39

Lab Eliminated: 23; 98

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



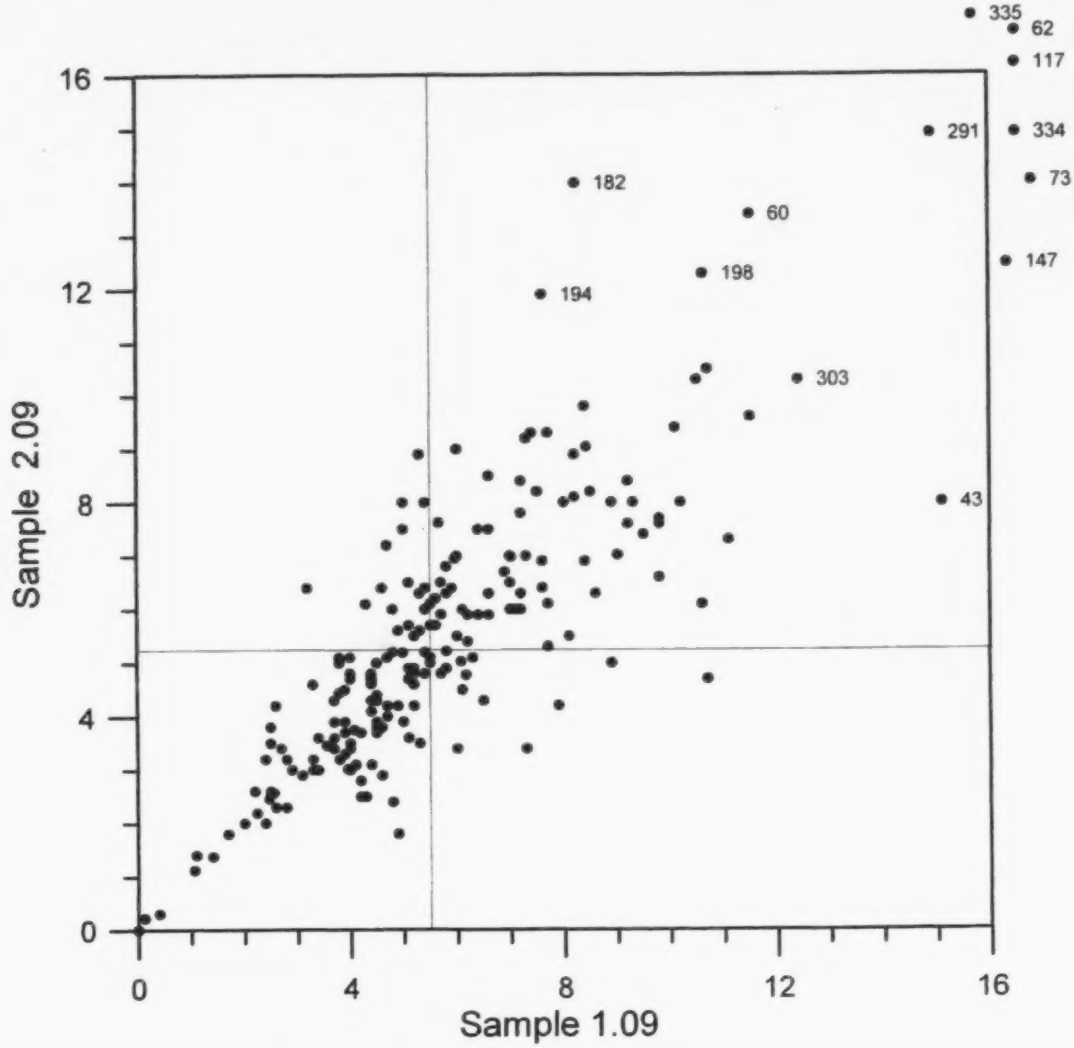
Test 12: Percent Crushed Particles

	Mat 1	Mat 2
Mean	56.924	57.175
Median	59.850	57.750
Std Dev	6.910	7.067

n = 215

Labs Eliminated: 98; 257; 269

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



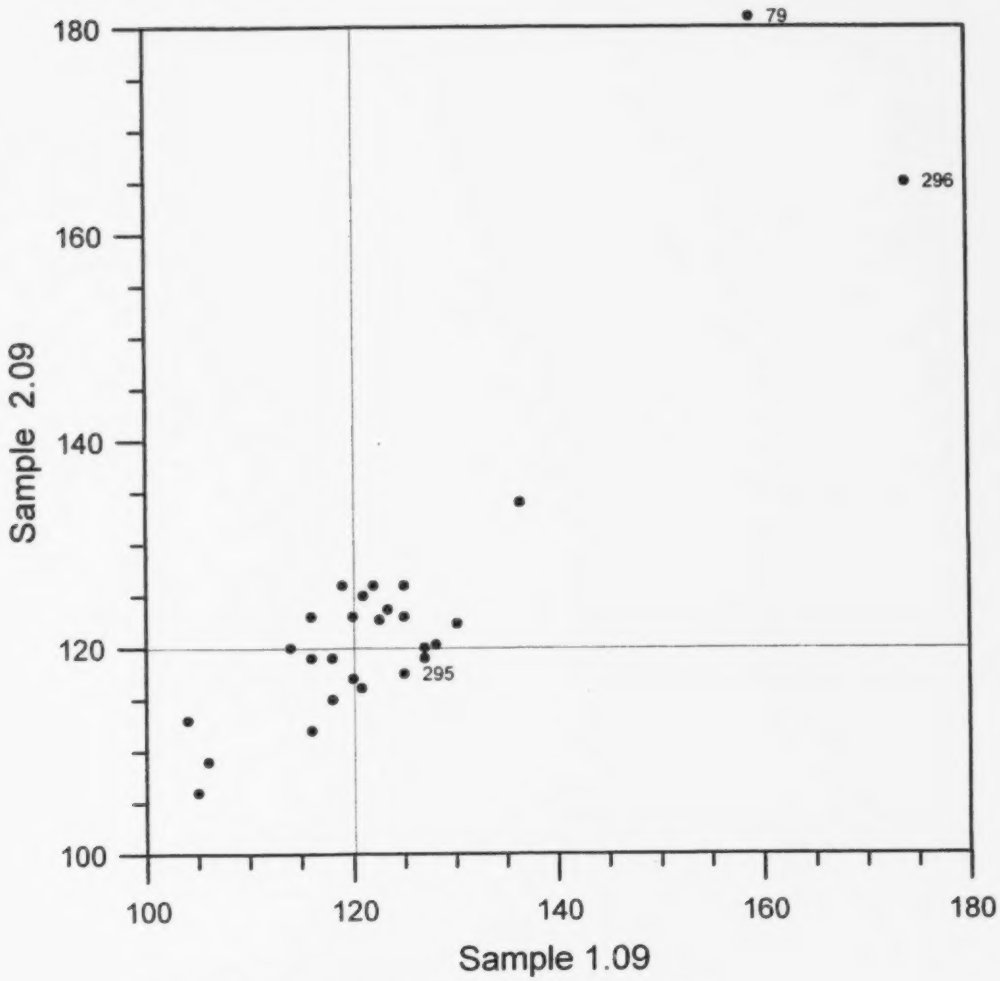
Test 13: Percent Flat and Elongated Particles

	Mat 1	Mat 2
Mean	5.529	5.255
Median	5.750	5.250
Std Dev	2.290	2.119

n = 194

Labs Eliminated: 43; 60; 62; 73; 117; 147; 182; 194; 198; 291; 303; 334; 335

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



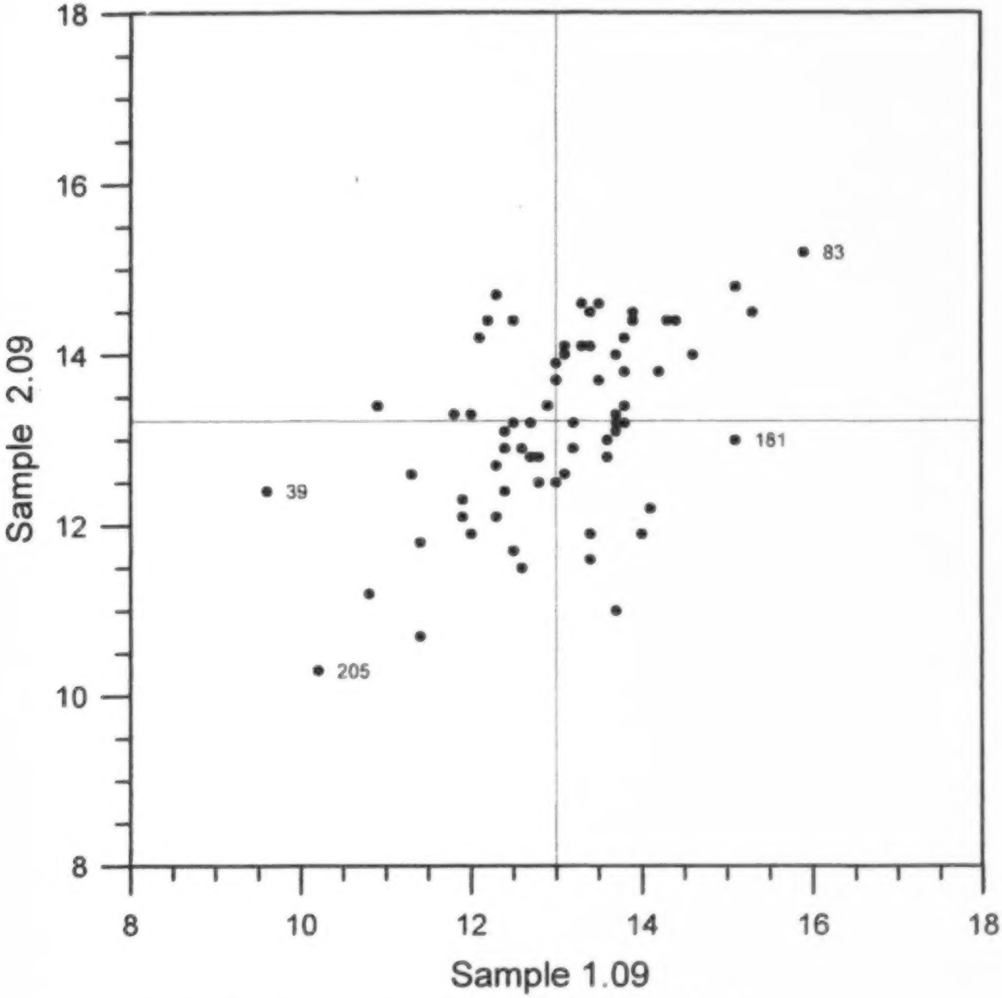
Test 14: Petrographic Number (Concrete)

	Mat 1	Mat 2
Mean	120.2	119.9
Median	120.2	120.0
Std Dev	7.6	6.0

n = 24

Lab Eliminated: 79; ; 295; 296

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



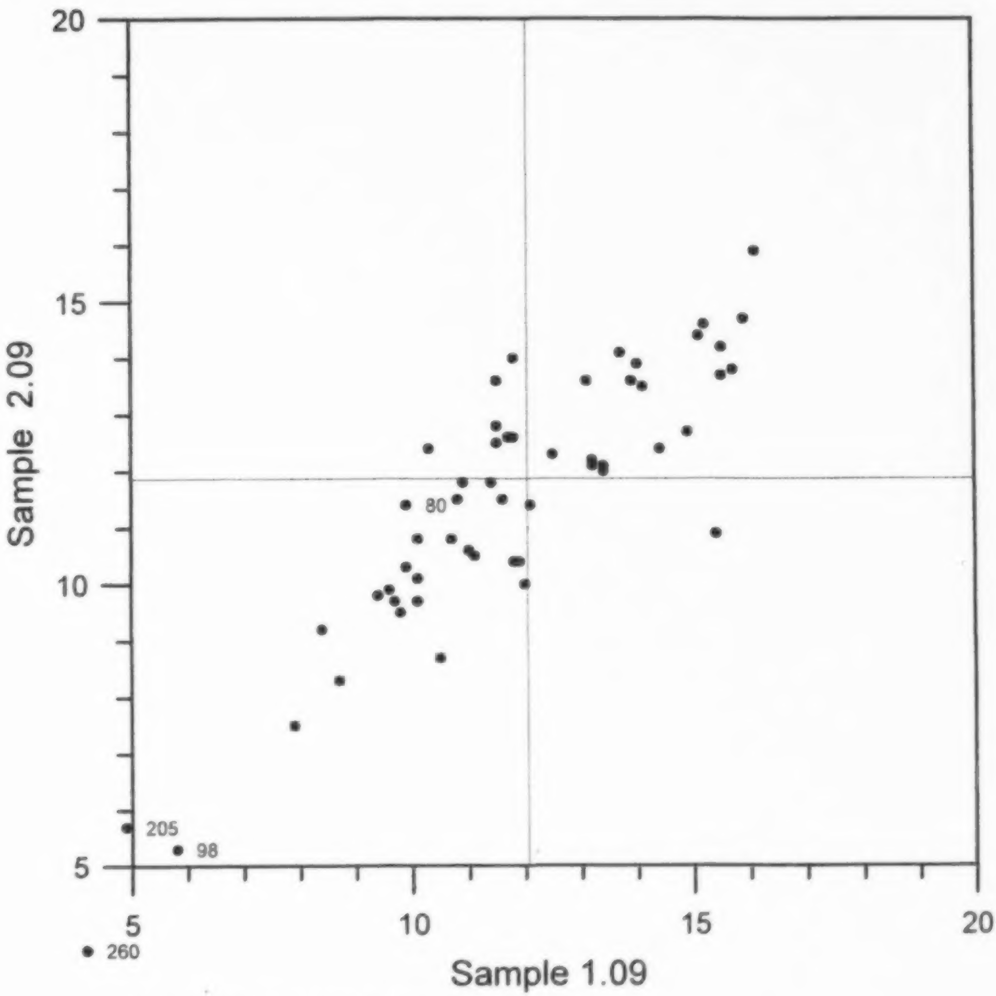
Test 16: Micro-Deval Abrasion Loss (CA), %

	Mat 1	Mat 2
Mean	13.042	13.167
Median	13.050	12.750
Std Dev	0.939	1.082

n = 66

Labs eliminated: 39; 83; 181; 205

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

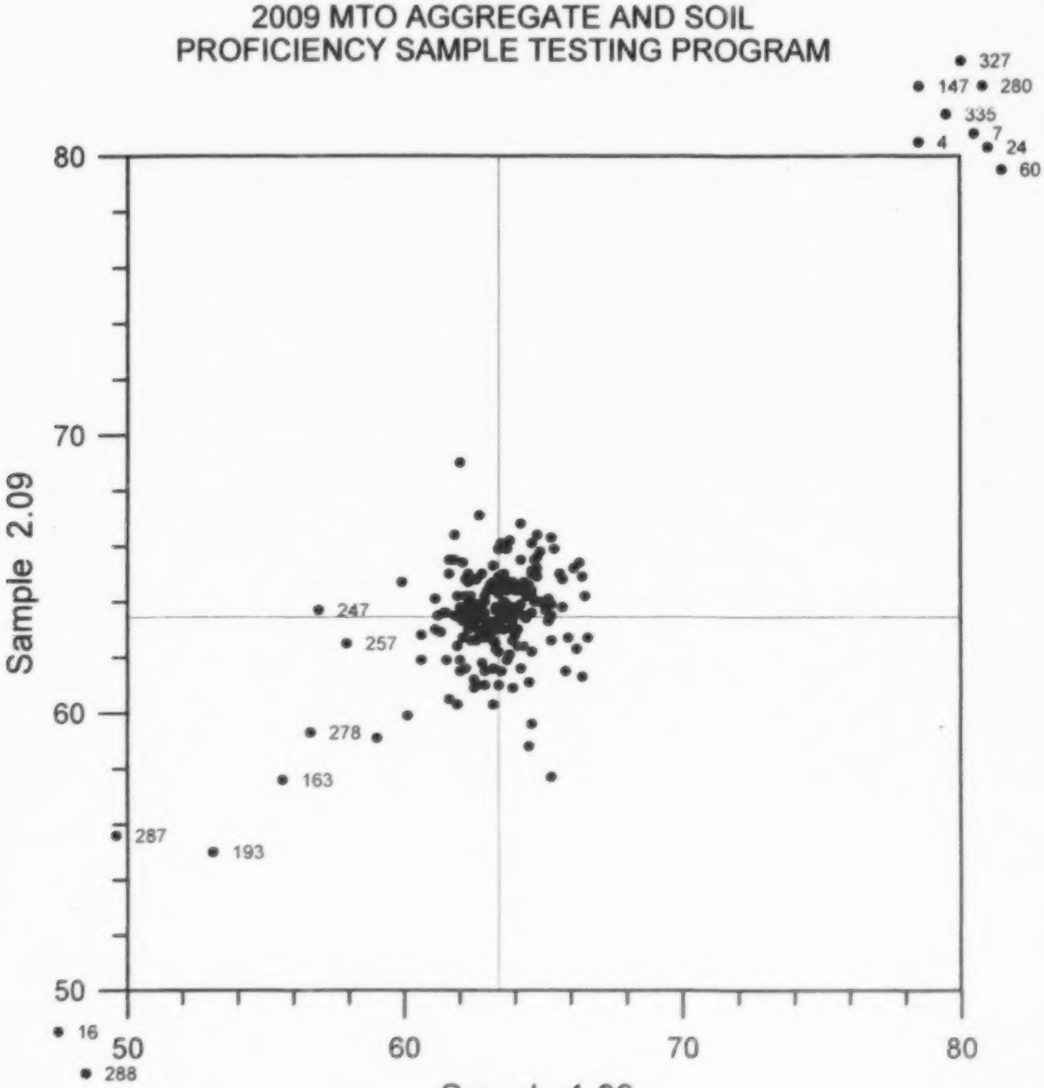


Test 17: Freeze-Thaw Loss, %

	Mat 1	Mat 2
Mean	12.116	11.786
Median	12.000	11.700
Std Dev	2.160	1.882

n = 51

Lab eliminated: 80; 98; 205; 260



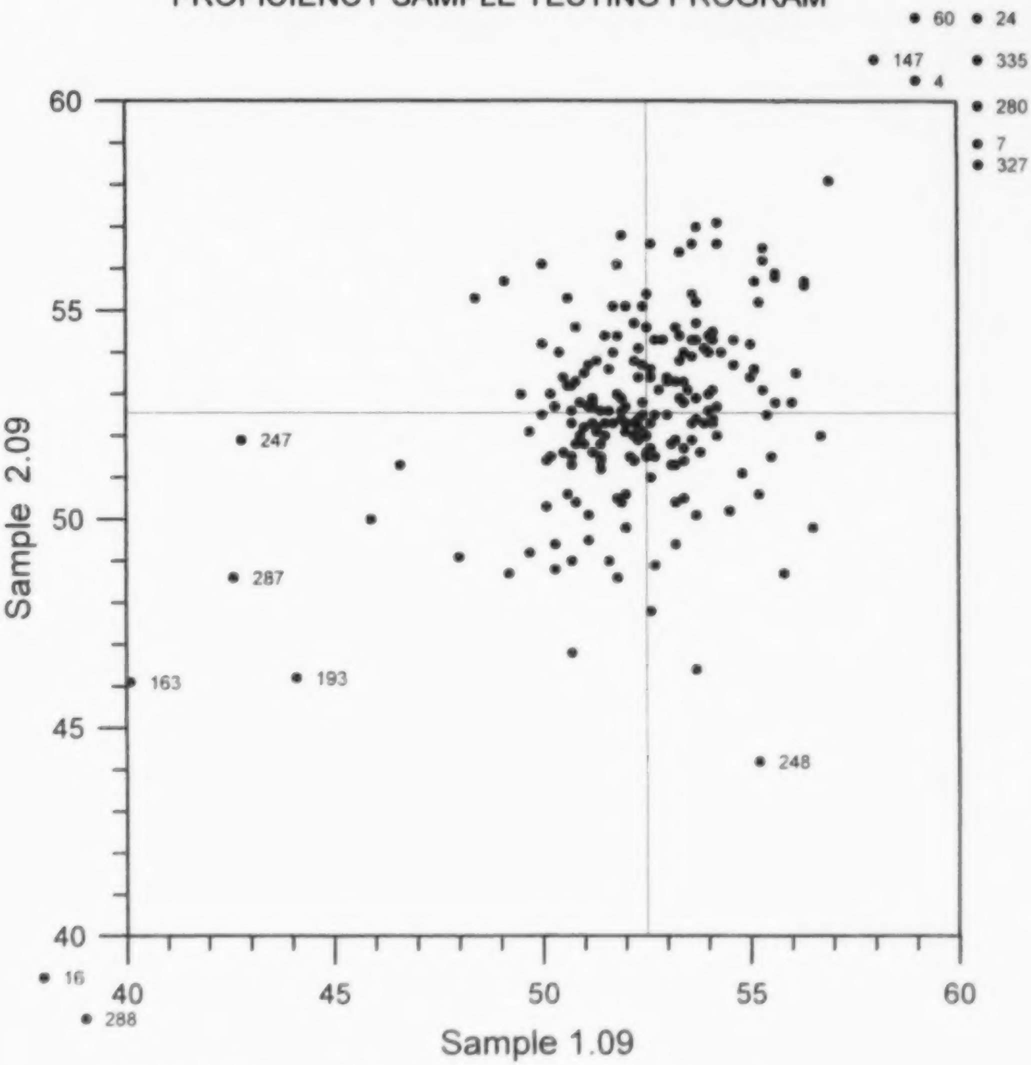
Test 20: Percent Passing the 2.36 mm Sieve

	Mat 1	Mat 2
Mean	63.447	63.534
Median	62.800	63.350
Std Dev	1.297	1.608

n = 202

Labs Eliminated: 4; 7; 16; 24; 60; 147; 163; 193; 247; 257; 278; 280
287; 288; 327; 335

2009 MTO AGGREGATE AND SOIL
PROFICIENCY SAMPLE TESTING PROGRAM



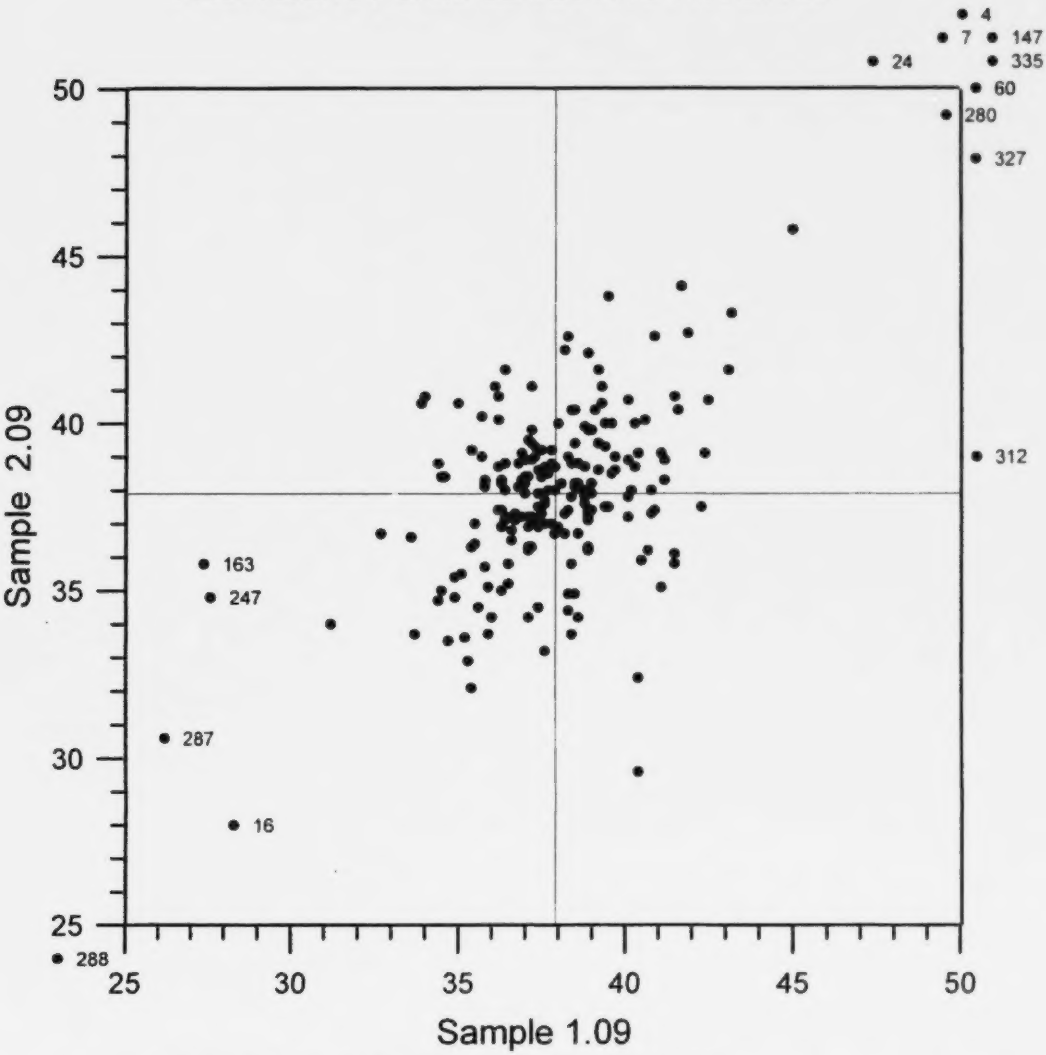
Test 21: Percent Passing the 1.18 mm Sieve

	Mat 1	Mat 2
Mean	52.514	52.627
Median	51.400	52.250
Std Dev	1.801	2.084

n = 203

Labs Eliminated: 4; 7; 16; 24; 60; 147; 163; 193; 247; 248; 280; 287; 288; 327; 335

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



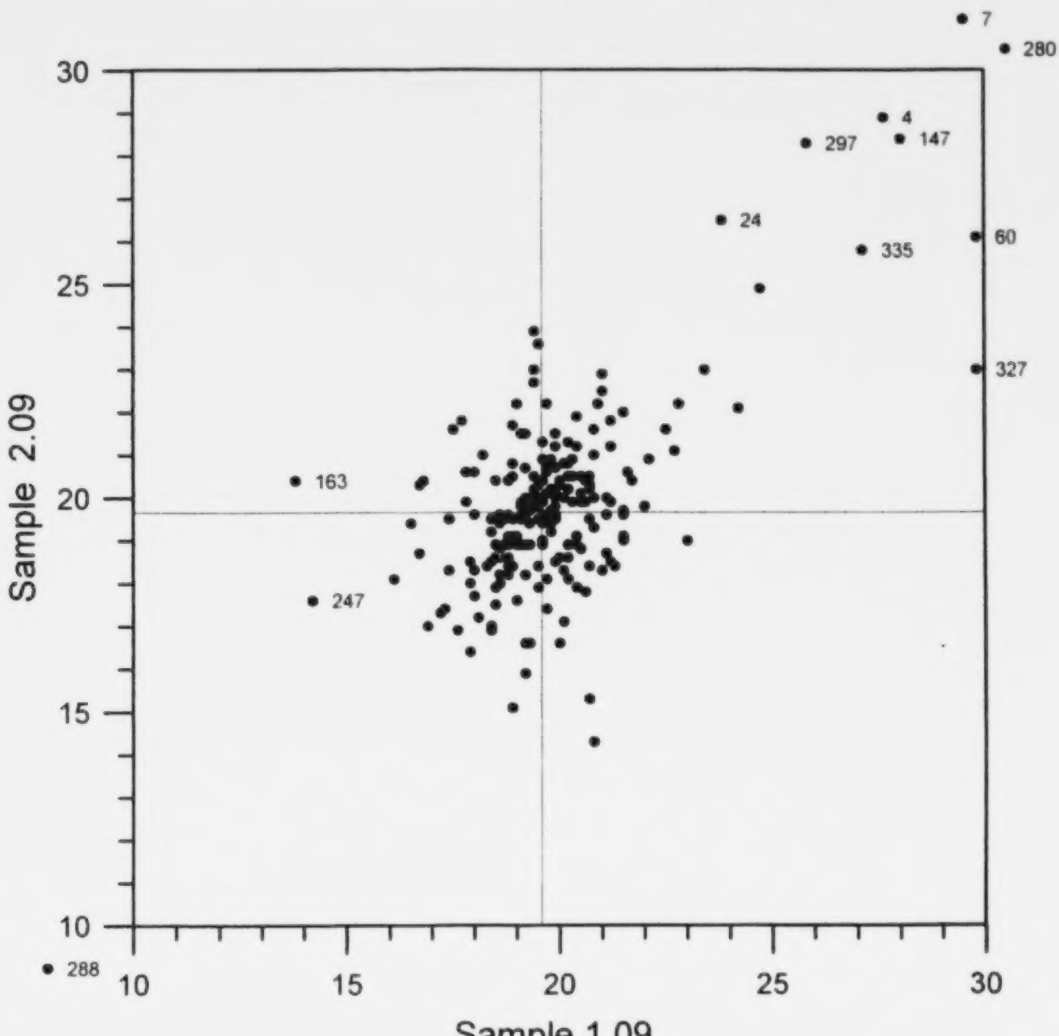
Test 22: Percent Passing the 600 um Sieve

	Mat 1	Mat 2
Mean	37.877	37.839
Median	38.100	37.700
Std Dev	2.083	2.337

n = 204

Lab Eliminated: 4; 7; 16; 24; 60; 147; 163; 247; 280; 287; 288; 312; 327; 335

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



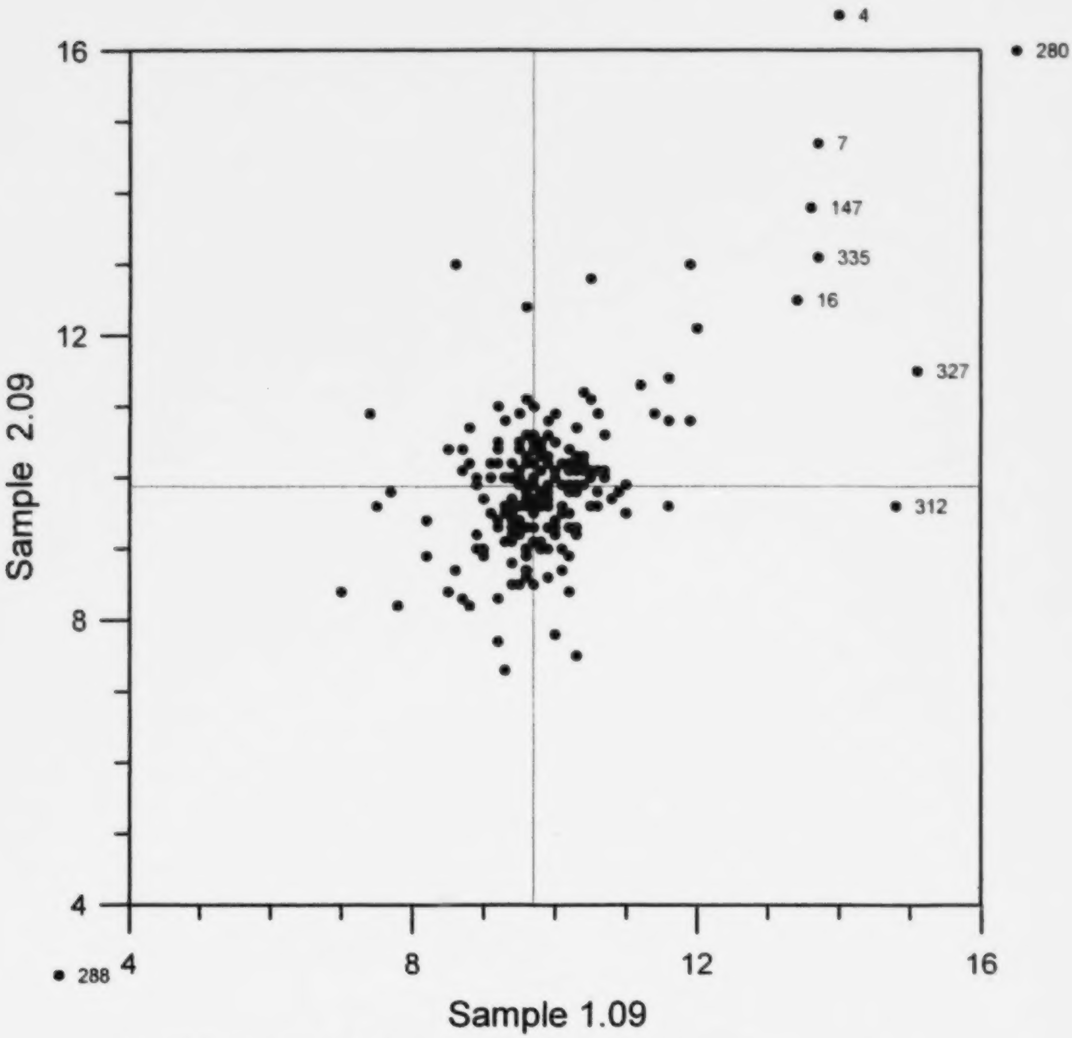
Test 23: Percent Passing the 300 um Sieve

	Mat 1	Mat 2
Mean	19.630	19.689
Median	20.400	19.600
Std Dev	1.347	1.701

n = 206

Lab Eliminated: 4; 7; 24; 60; 147; 163; 247; 280; 288; 297; 327; 335

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



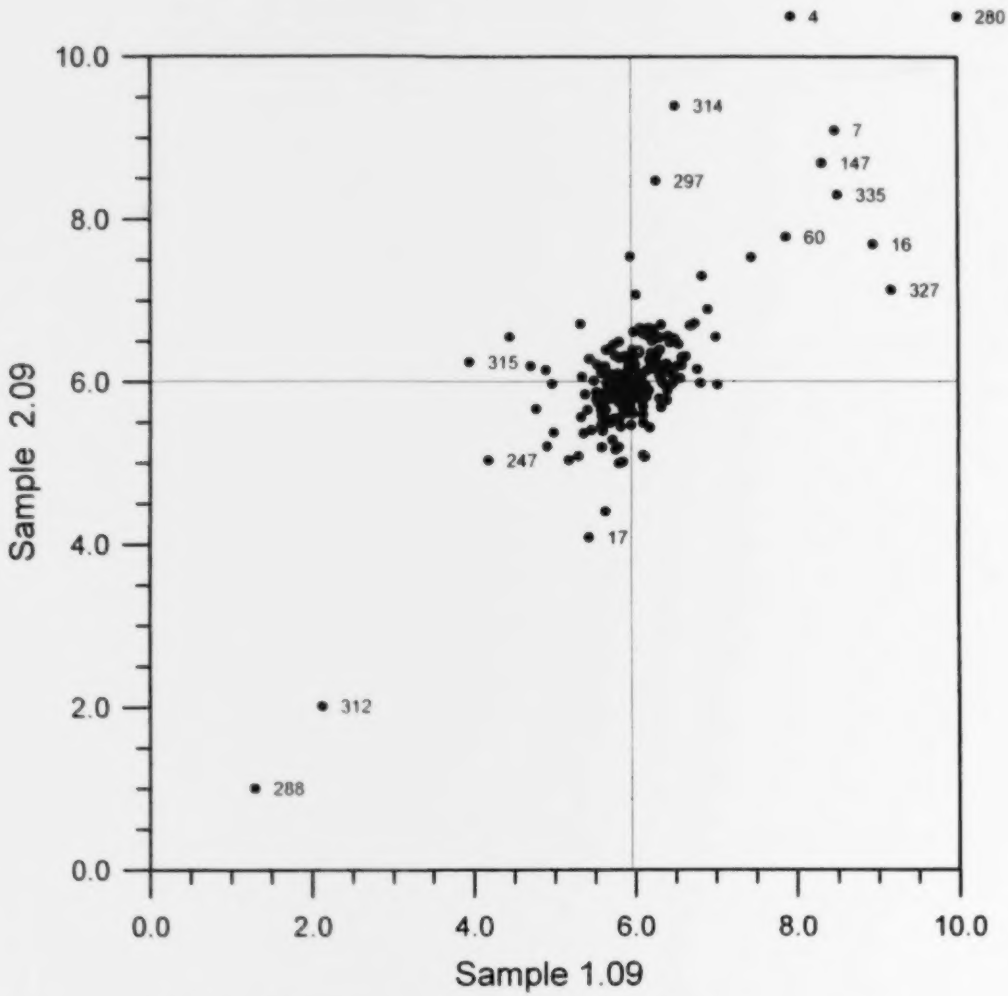
Test 24: Percent Passing the 150 um Sieve

	Mat 1	Mat 2
Mean	9.723	9.842
Median	9.500	10.150
Std Dev	0.734	0.892

n = 209

Lab Eliminated: 4; 7; 16; 147; 280; 288; 312; 327; 335

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



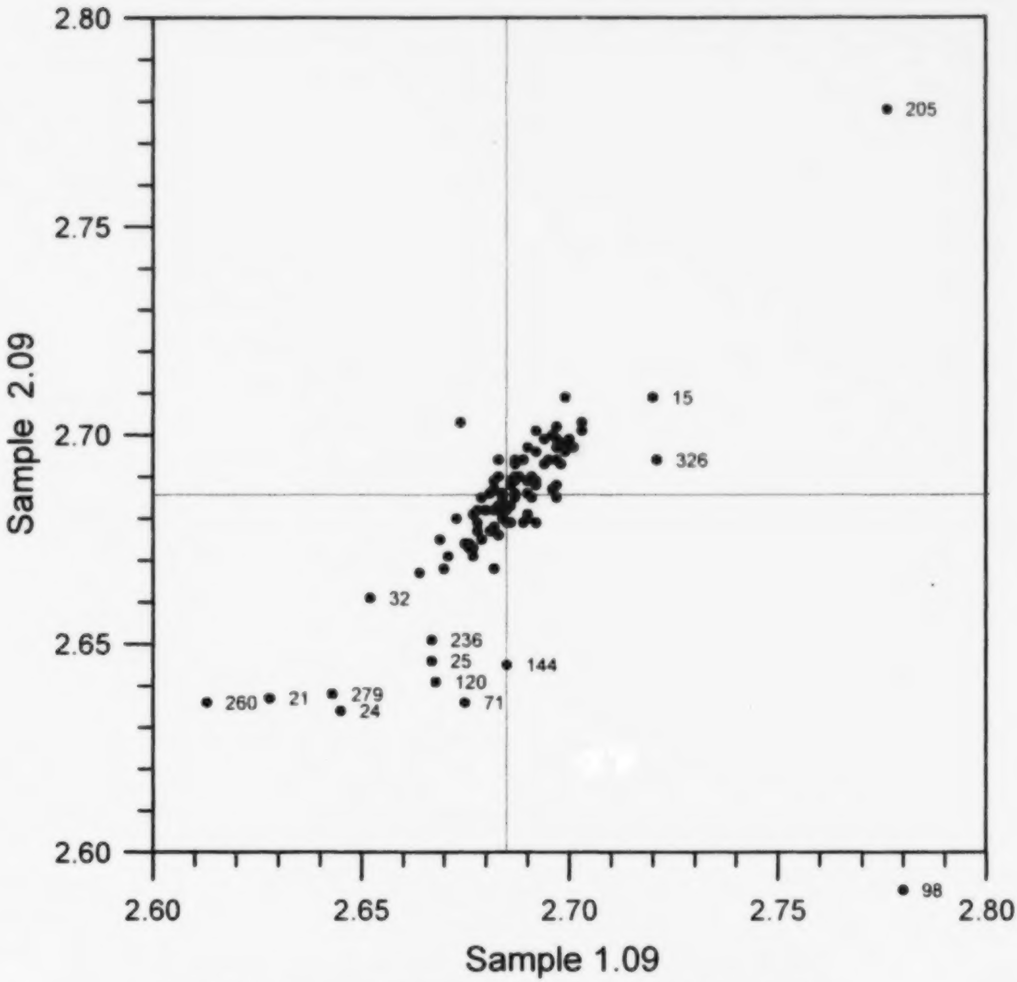
Test 25: Percent Passing the 75 um Sieve

	Mat 1	Mat 2
Mean	5.950	6.017
Median	5.940	5.980
Std Dev	0.422	0.447

n = 203

Labs Eliminated: 4; 7; 16; 17; 60; 147; 247; 280; 288; 297; 312; 314; 315; 327; 335

2009 MTO AGGREGATE AND SOIL
PROFICIENCY SAMPLE TESTING PROGRAM



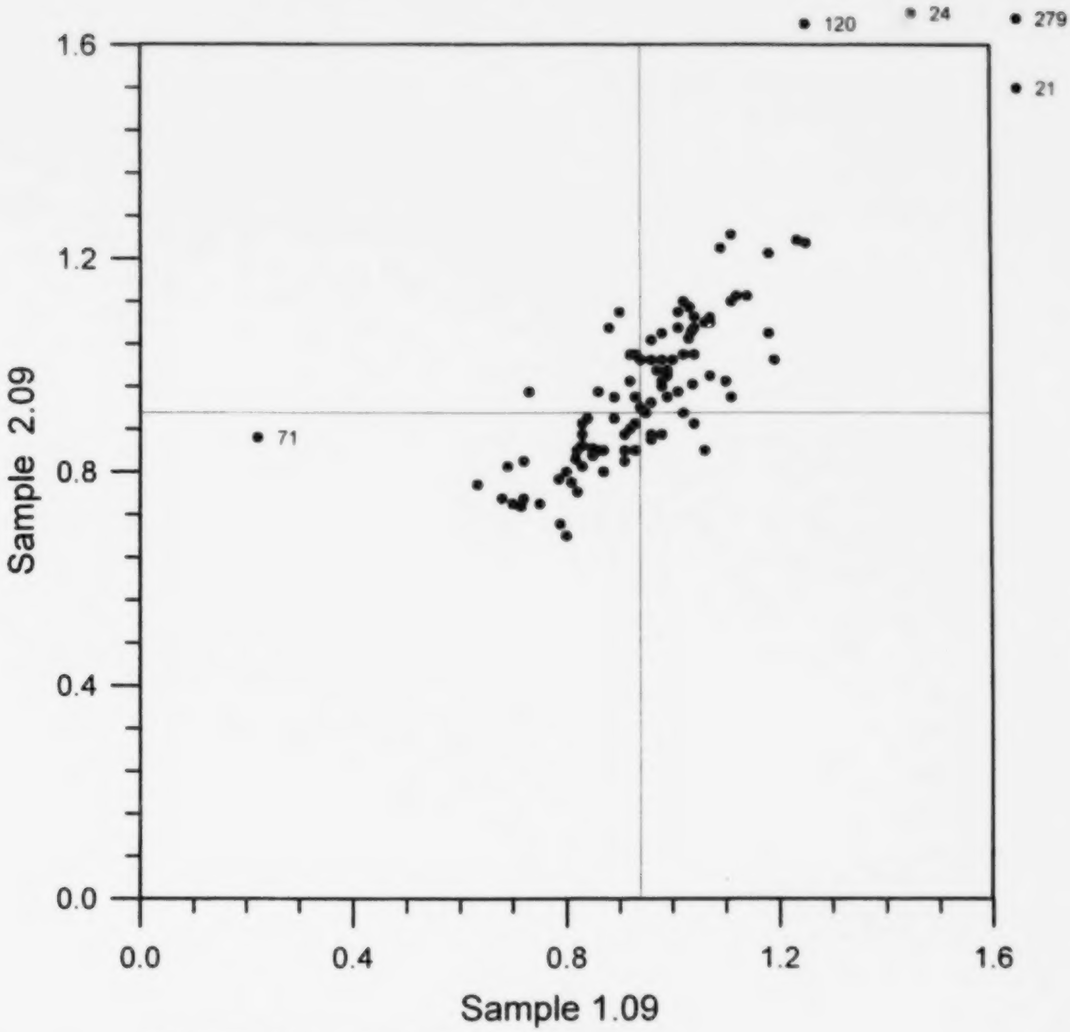
Test 27: Relative Density, (Fine Aggregate - Bulk)

	Mat 1	Mat 2
Mean	2.686	2.687
Median	2.684	2.688
Std Dev	0.009	0.010

n = 88

Labs Eliminated: 15; 21; 24; 25; 32; 71; 98; 120; 144; 205; 236; 260; 279; 326

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



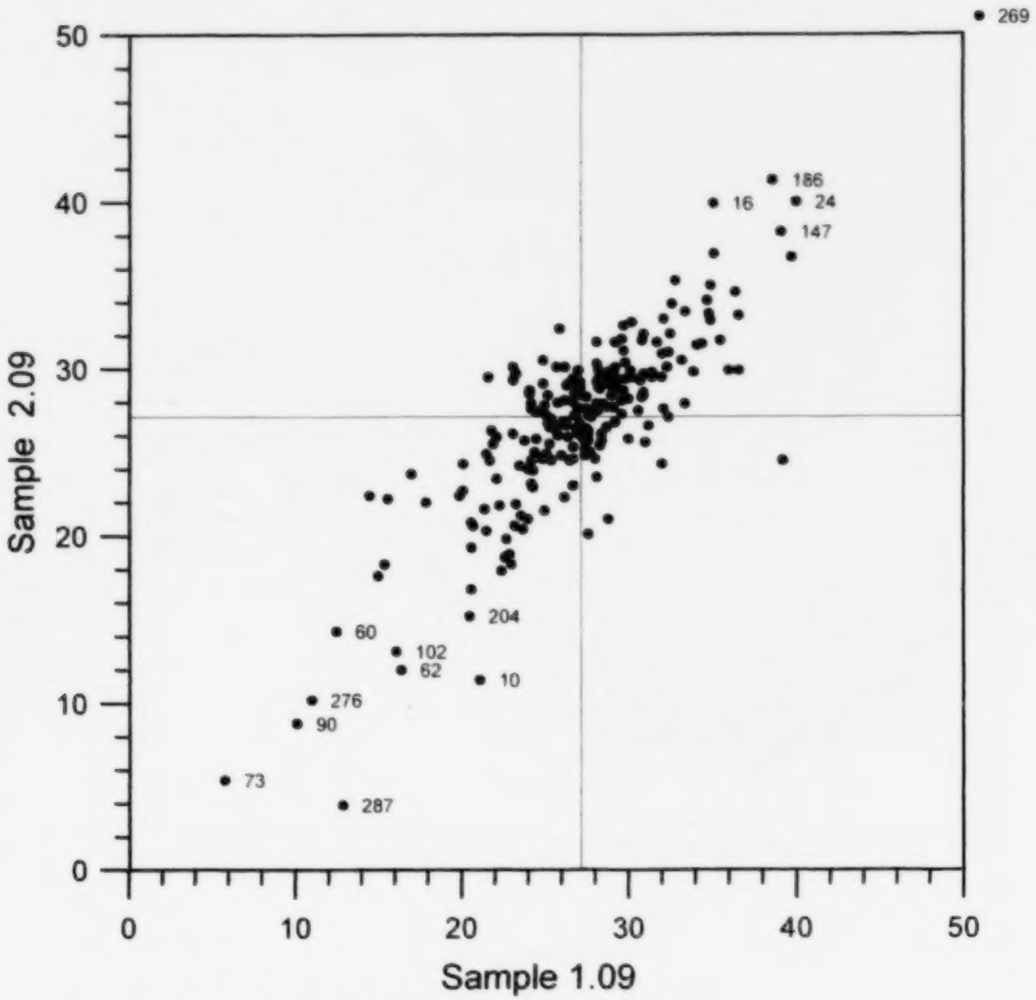
Test 28: Absorption (Fine Aggregate)

	Mat 1	Mat 2
Mean	0.940	0.940
Median	0.942	0.963
Std Dev	0.134	0.130

n = 97

Labs Eliminated: 21; 24; 71; 120; 279

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



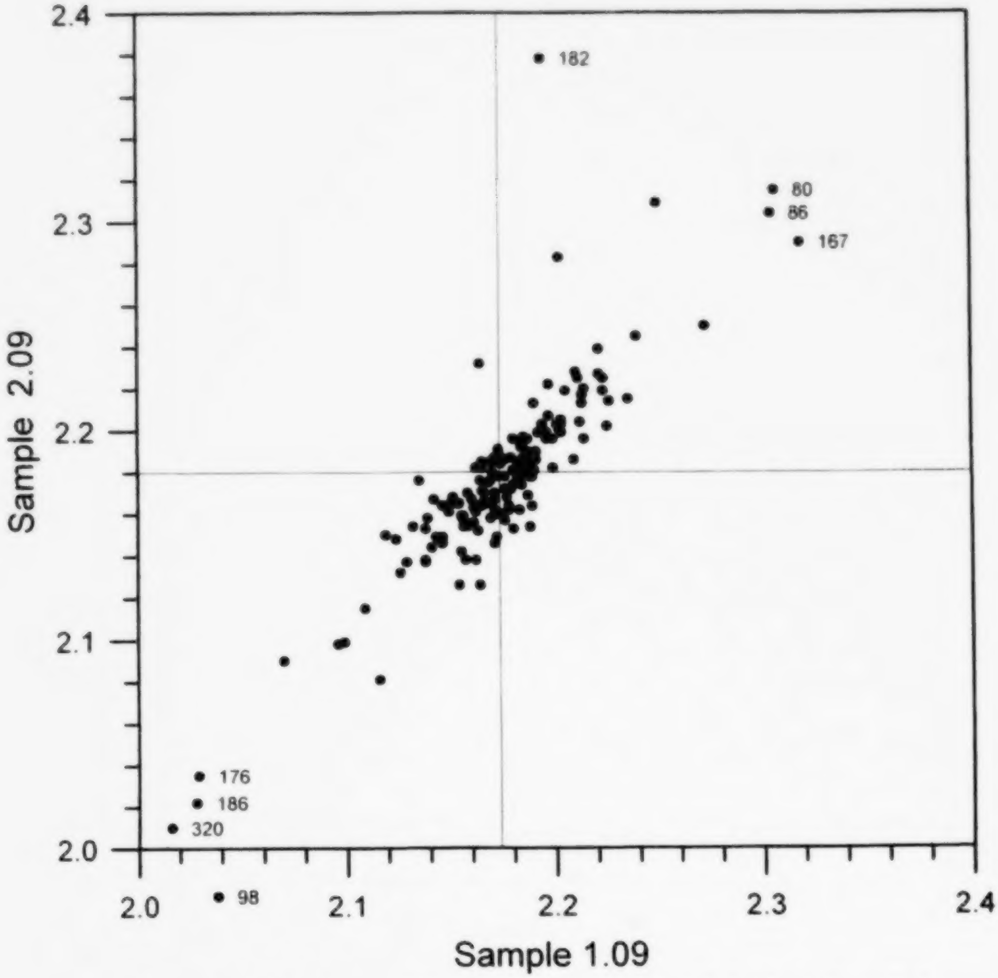
Test 30: Percent Asphalt Coated Particles

	Mat 1	Mat 2
Mean	27.291	27.169
Median	27.100	26.850
Std Dev	4.674	3.795

n = 203

Lab Eliminated: 10; 16; 24; 60; 62; 73; 90; 102; 147; 186; 204; 269; 276; 287

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



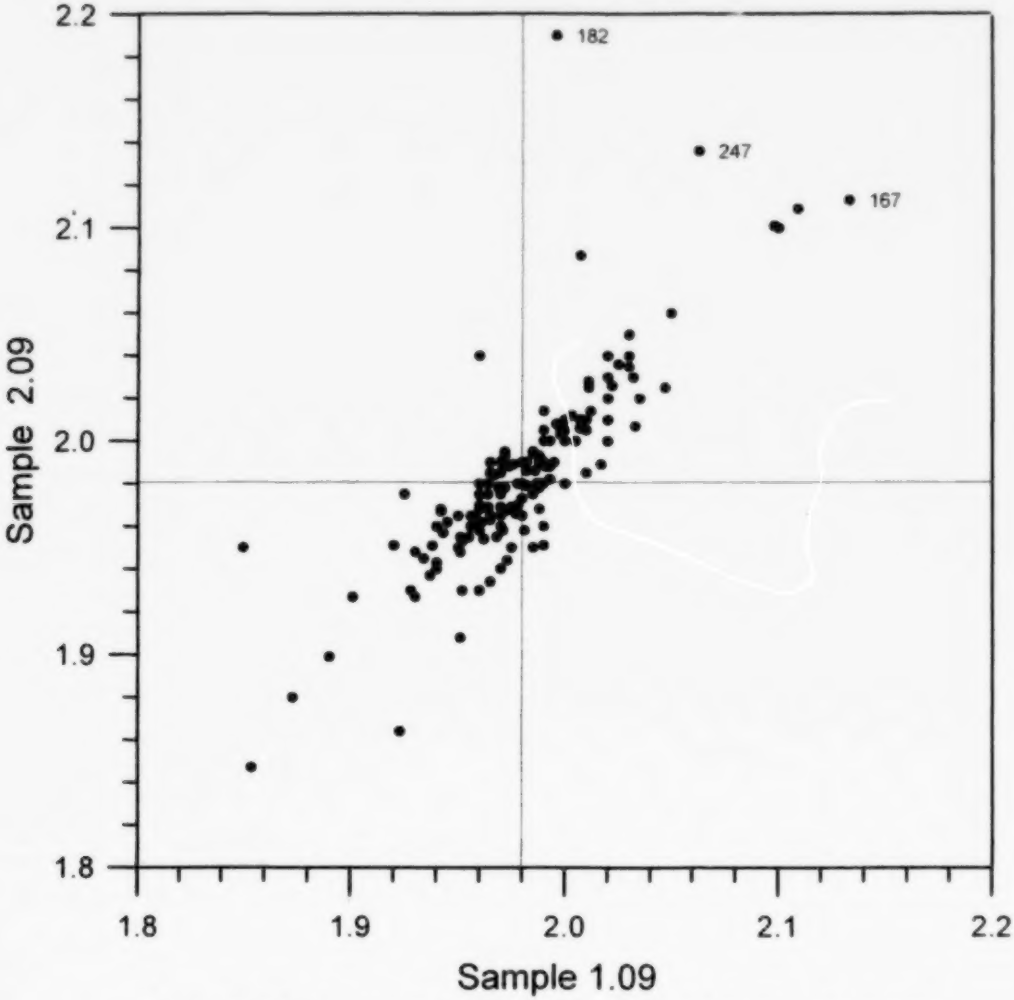
Test 31: Maximum Wet Density g/cm3 (Moisture-Density)

	Mat 1	Mat 2
Mean	2.176	2.180
Median	2.171	2.195
Std Dev	0.029	0.036

n = 150

Labs Eliminated: 80; 86; 98; 167; 176; 182; 186; 320

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



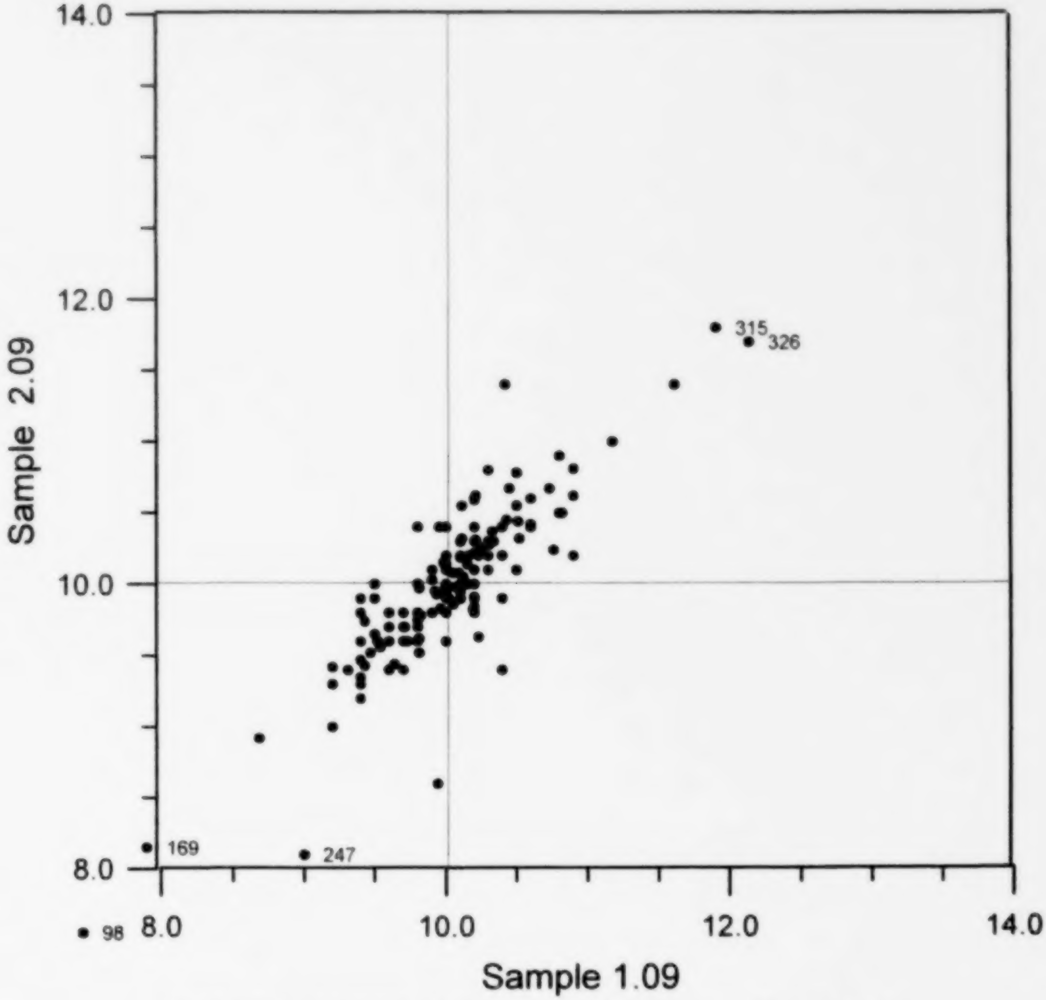
Test 32: Maximum Dry Density g/cm3 (Moisture-Density)

	Mat 1	Mat 2
Mean	1.979	1.982
Median	1.980	1.978
Std Dev	0.037	0.039

n = 155

Labs Eliminated: 167; 182; 247

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



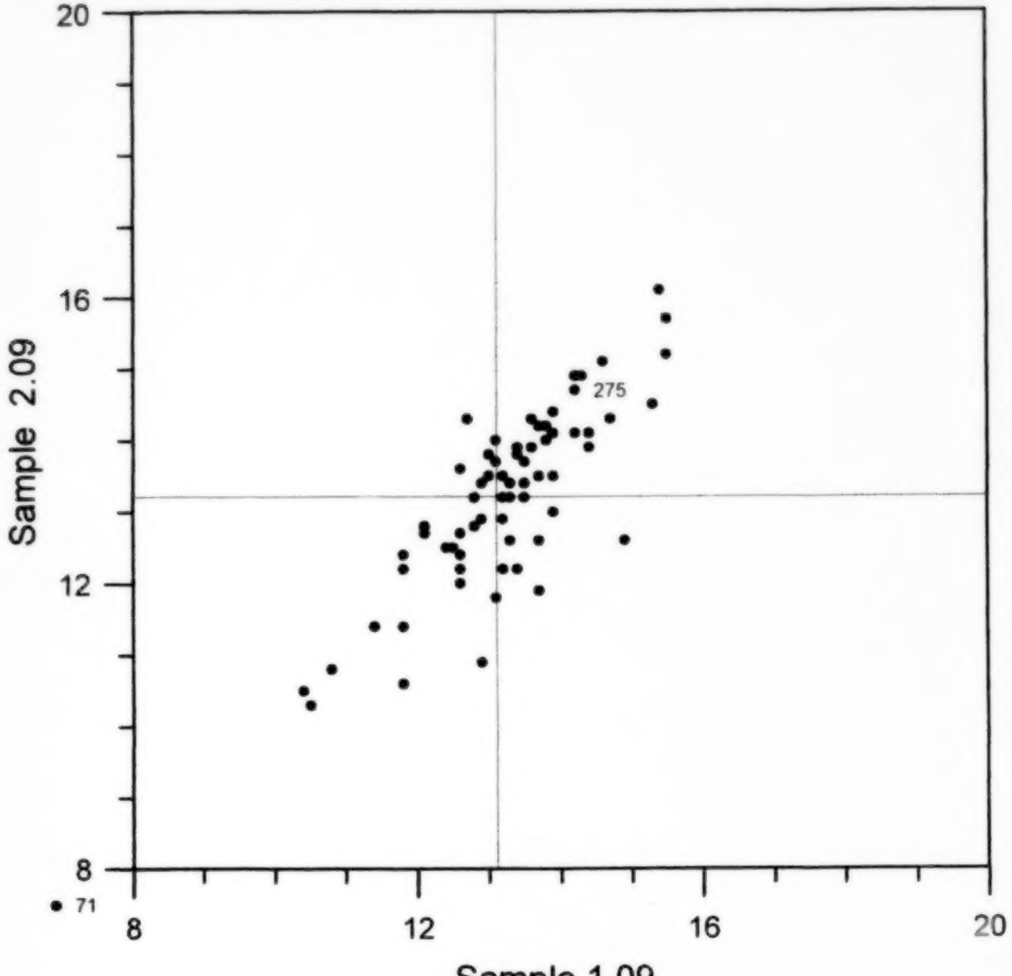
Test 33: Optimum Moisture, % (Moisture - Density)

	Mat 1	Mat 2
Mean	10.037	10.040
Median	10.145	10.000
Std Dev	0.441	0.485

n = 153

Labs Eliminated: 98; 169; 247; 315; 326

2009 MTO AGGREGATE AND SOIL
PROFICIENCY SAMPLE TESTING PROGRAM



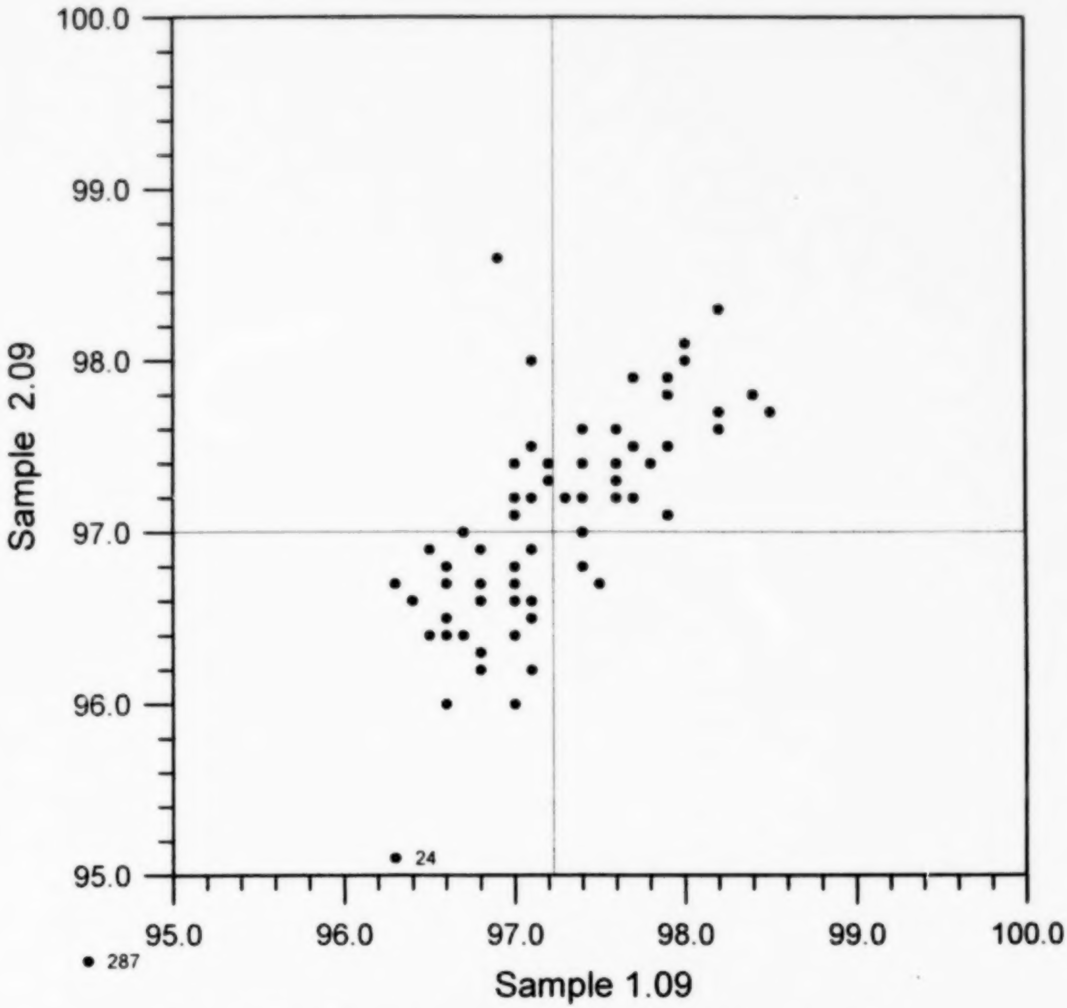
Test 34: Micro-Deval Abrasion Loss (FA), %

	Mat 1	Mat 2
Mean	13.253	13.207
Median	12.950	13.200
Std Dev	1.065	1.211

n = 68

Lab eliminated: 71; 275

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



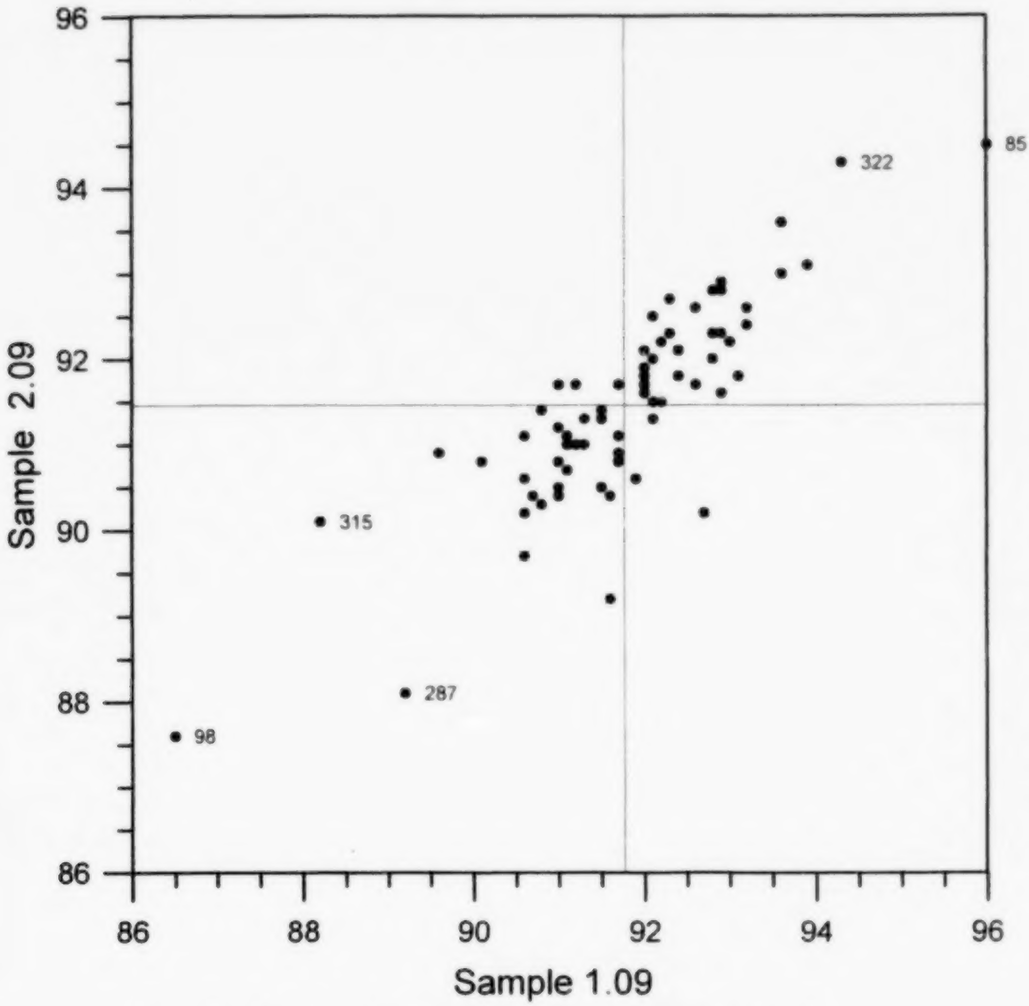
Test 41: Percent Passing the 425 μm Sieve (Soil)

	Mat 1	Mat 2
Mean	97.224	97.070
Median	97.400	97.300
Std Dev	0.526	0.591

n = 69

Labs eliminated: 24; 287

2009 MTO AGGREGATE AND SOIL
PROFICIENCY SAMPLE TESTING PROGRAM



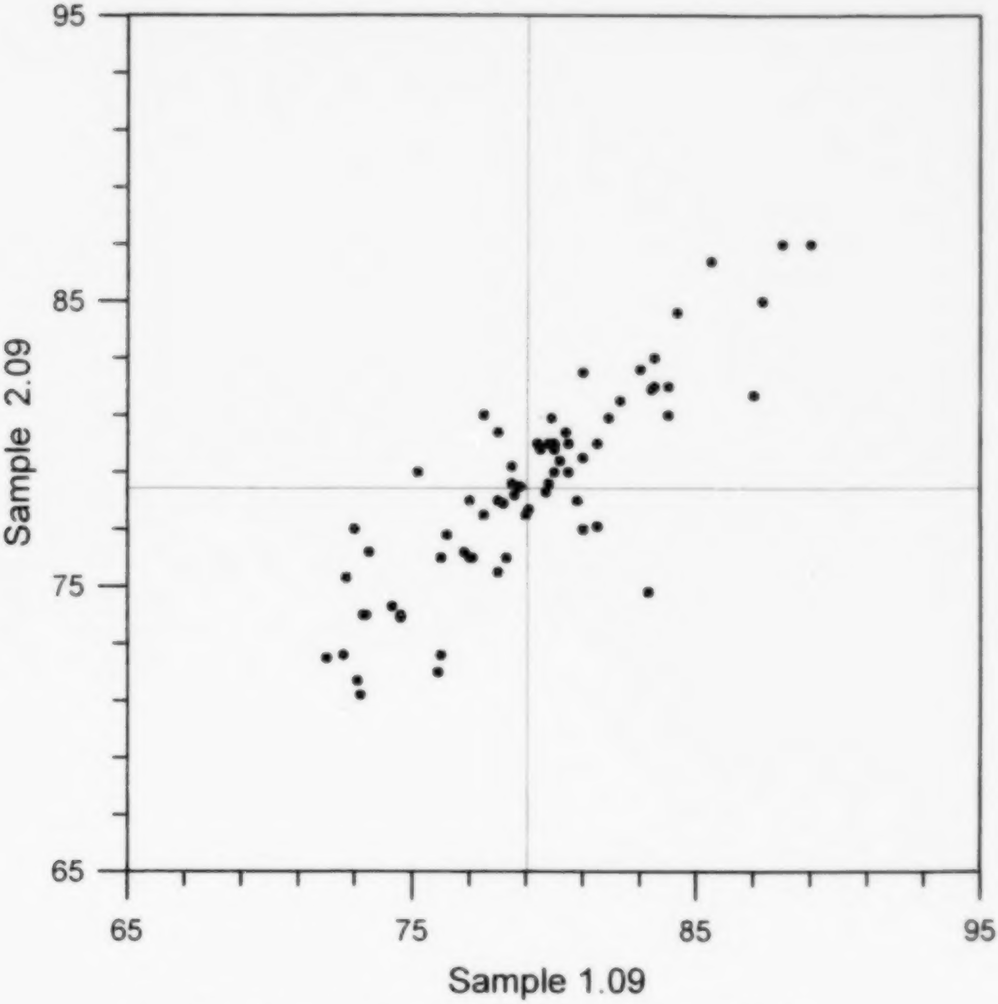
Test 42: Percent Passing the 75 μm Sieve (Soil)

	Mat 1	Mat 2
Mean	91.834	91.452
Median	91.750	91.400
Std Dev	1.014	0.918

n = 66

Labs eliminated: 85; 98; 287; 315; 322

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



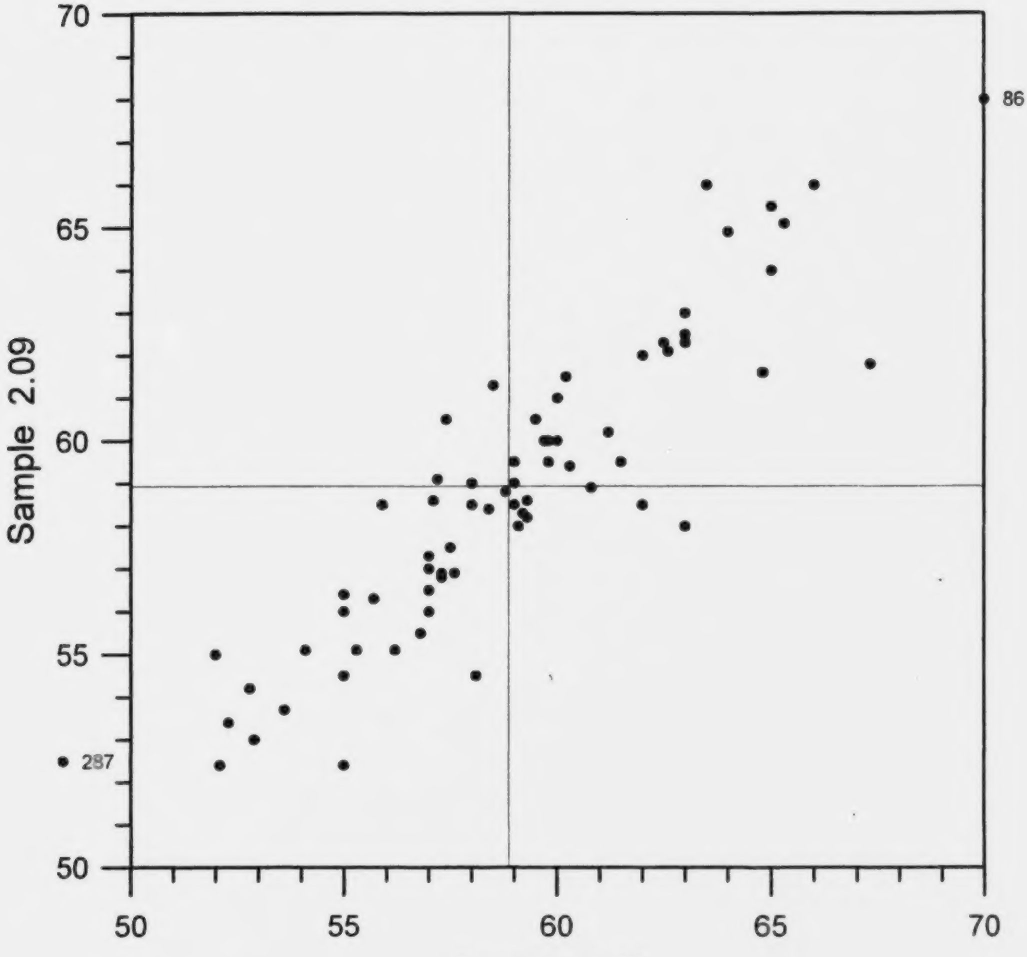
Test 43: Percent Passing the 20 μm Sieve (Soil)

	Mat 1	Mat 2
Mean	79.155	78.500
Median	80.500	79.100
Std Dev	3.888	3.541

n = 71

Labs eliminated: None

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



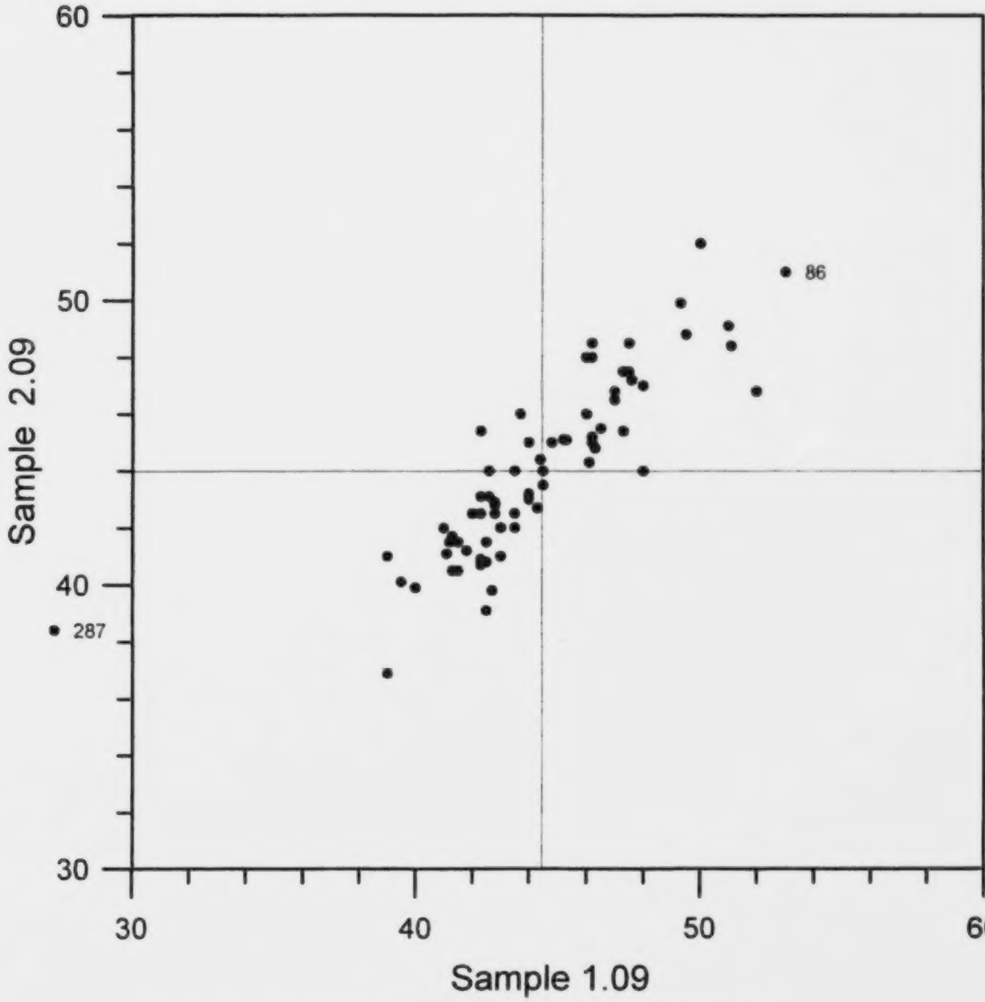
Test 44: Percent Passing the 5 μm Sieve (Soil)

	Mat 1	Mat 2
Mean	58.914	58.794
Median	59.650	59.200
Std Dev	3.557	3.496

n = 69

Labs eliminated: 86; 287

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



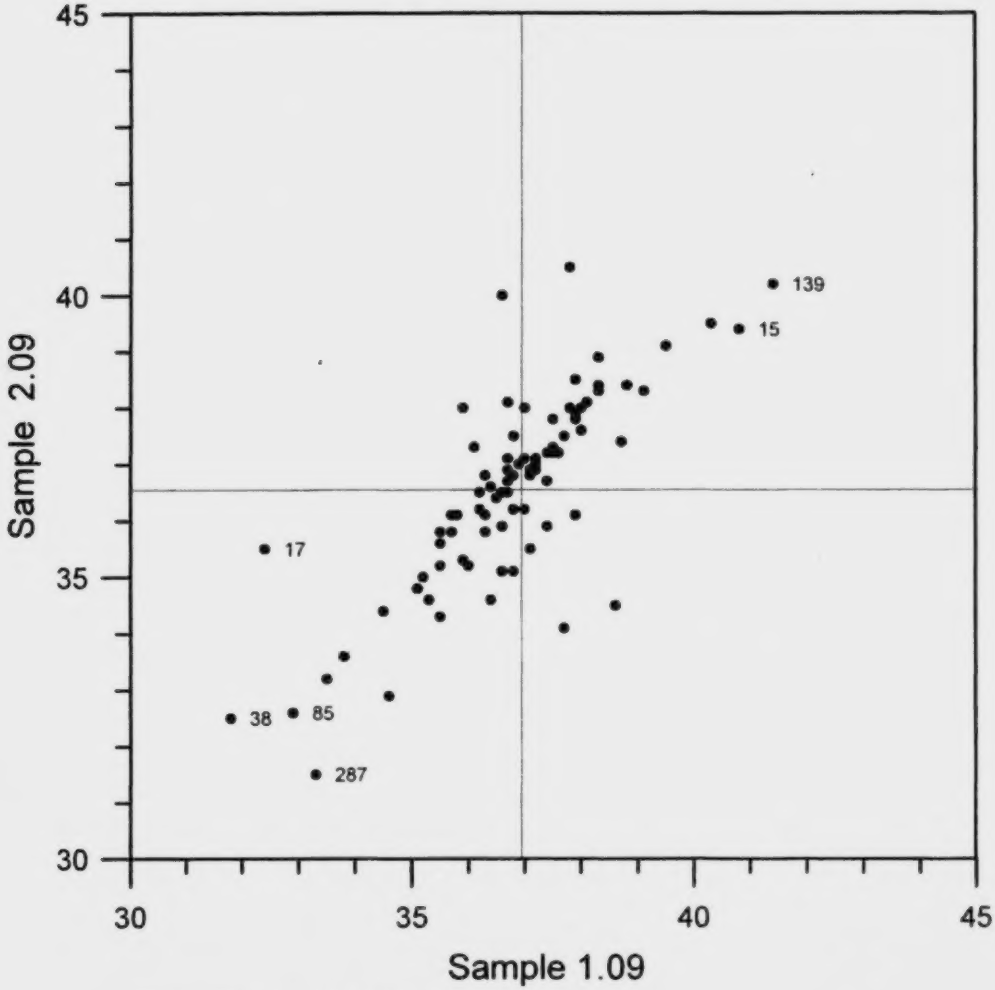
Test 45: Percent Passing the 2 μm Sieve (Soil)

	Mat 1	Mat 2
Mean	44.377	43.980
Median	45.500	44.450
Std Dev	2.945	3.103

n = 69

LabsEliminated: 86; 287

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



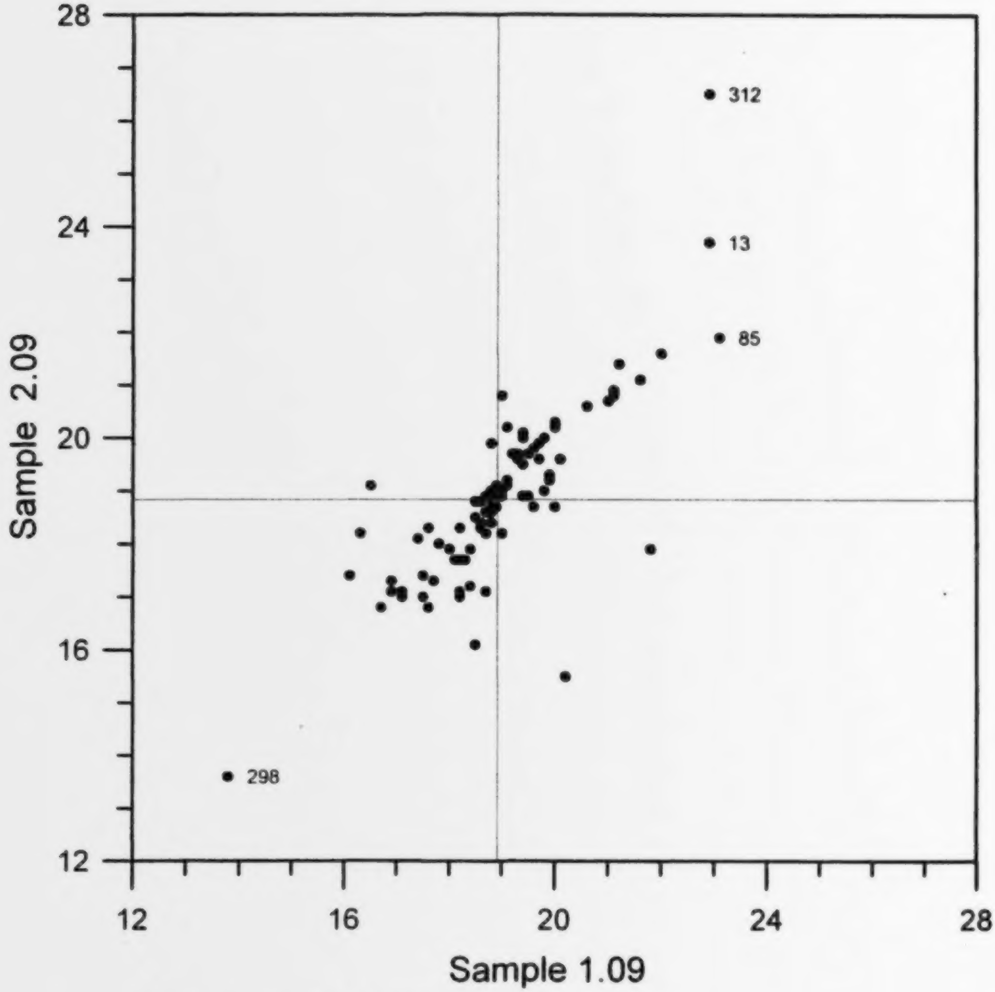
Test 46: Liquid Limit, %

	Mat 1	Mat 2
Mean	36.893	36.667
Median	36.900	36.700
Std Dev	1.324	1.683

n = 79

Lab eliminated: 15; 17; 38; 85; 139; 287

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



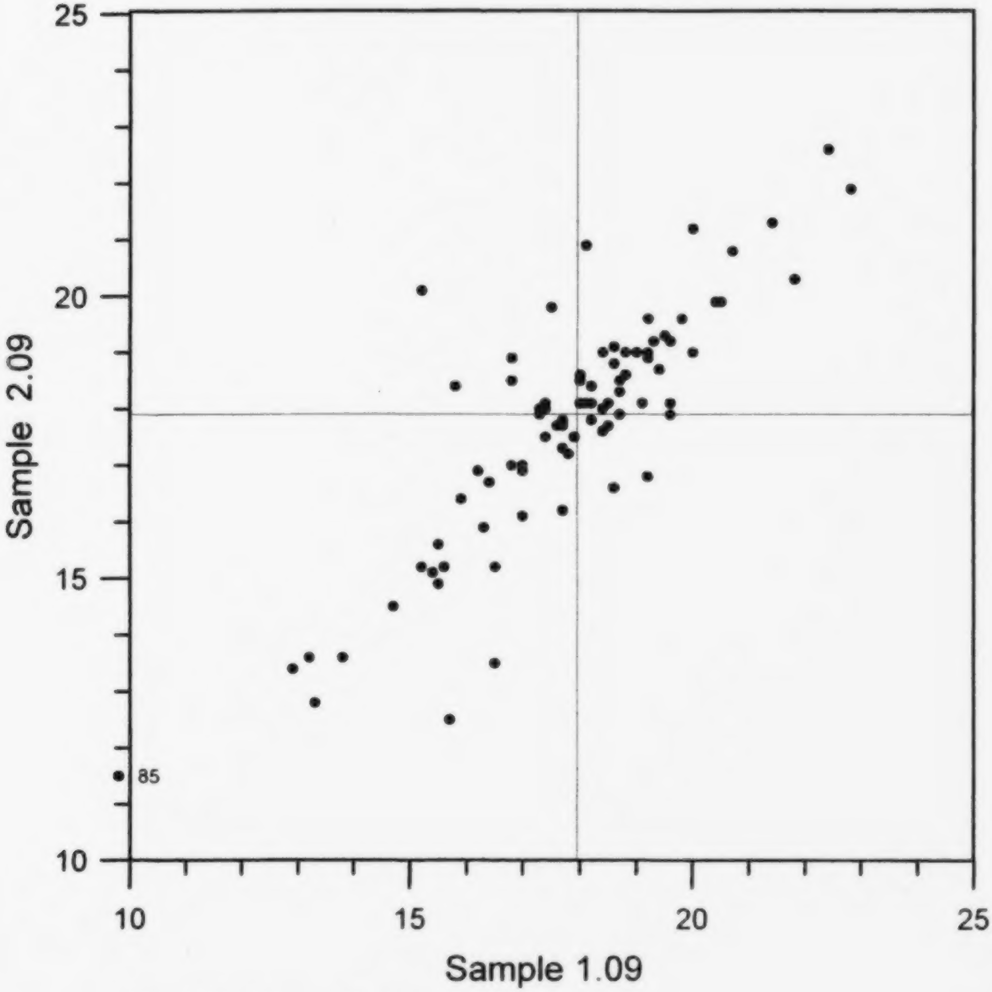
Test 47: Plastic Limit, %

	Mat 1	Mat 2
Mean	18.910	18.784
Median	19.050	18.550
Std Dev	1.223	1.300

n = 81

Labs eliminated: 13; 85; 298; 312

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



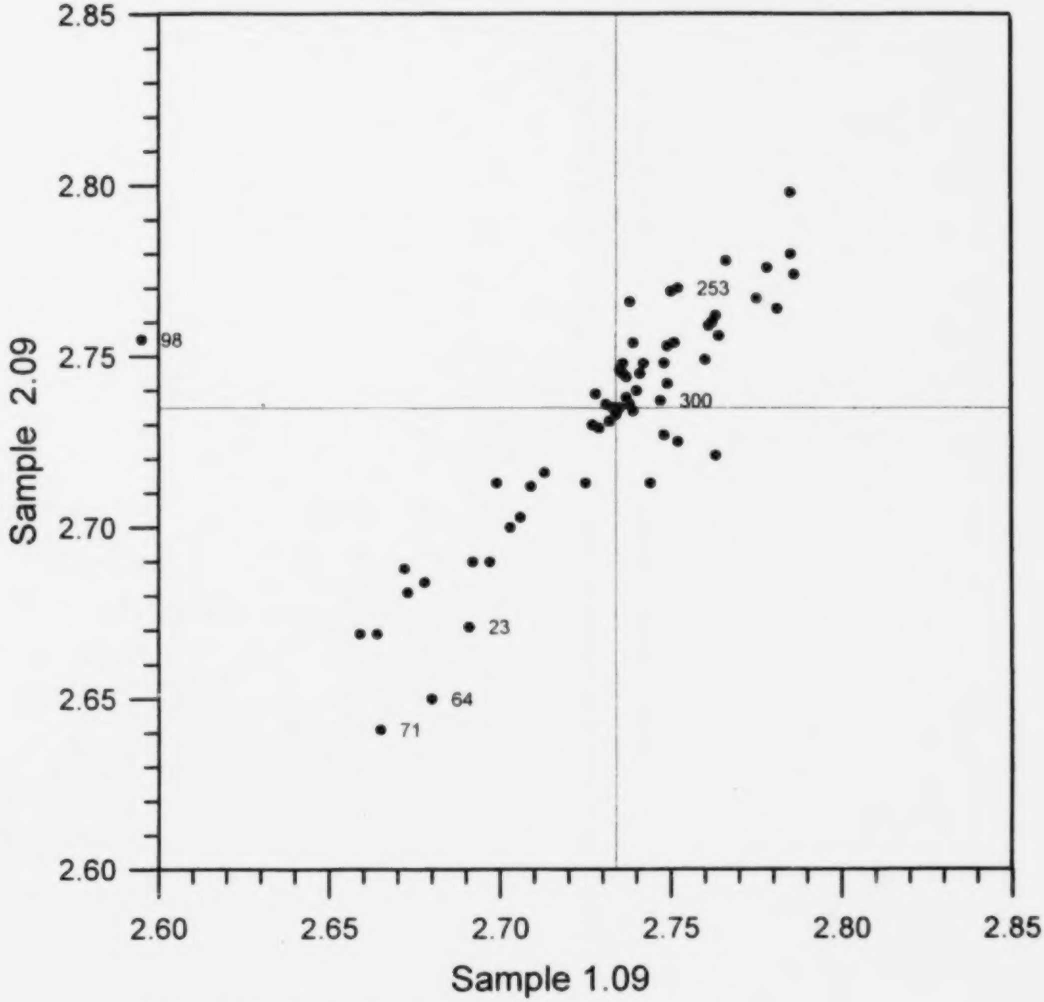
Test 48: Plasticity Index, %

	Mat 1	Mat 2
Mean	17.940	17.850
Median	17.850	17.550
Std Dev	1.955	2.046

n = 84

Lab eliminated: 85

2009 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



Test 49: Specific Gravity of Soil

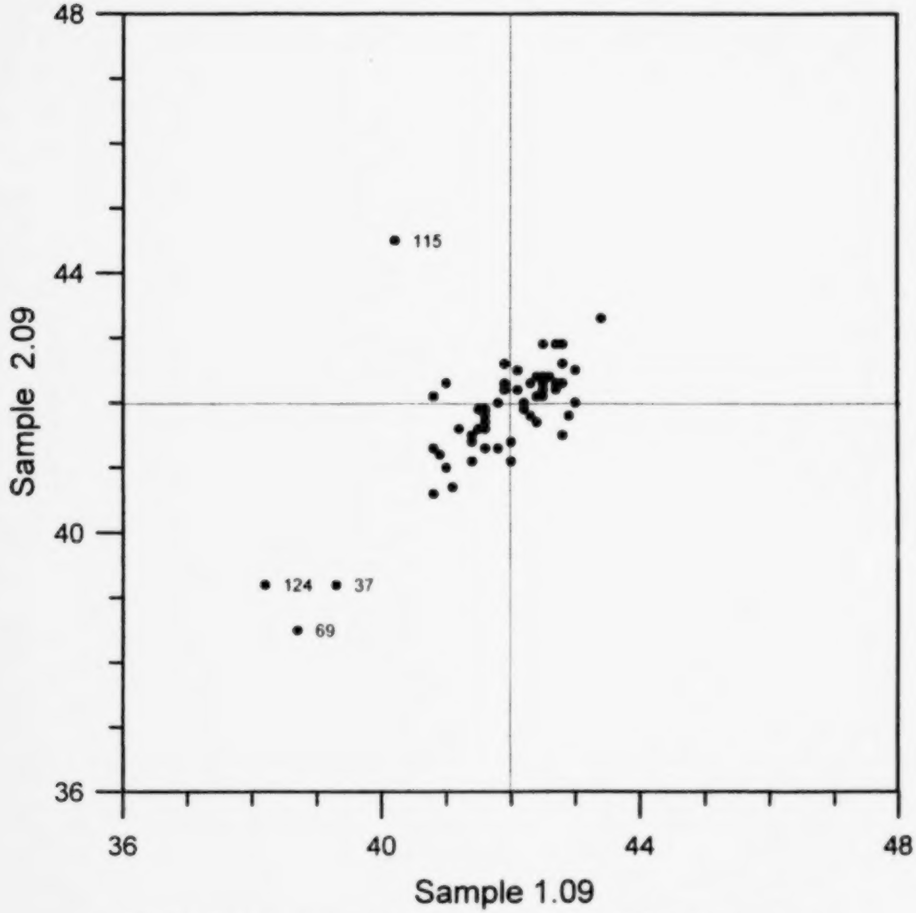
	Mat 1	Mat 2
Mean	2.734	2.735
Median	2.723	2.734
Std Dev	0.031	0.029

n = 54

Labs Eliminated: 23; 64; 71; 98; 253; 300

Appendix D2: Scatter Diagrams

2009 MTO SUPERPAVE
CONSENSUS PROPERTY TESTING PROGRAM



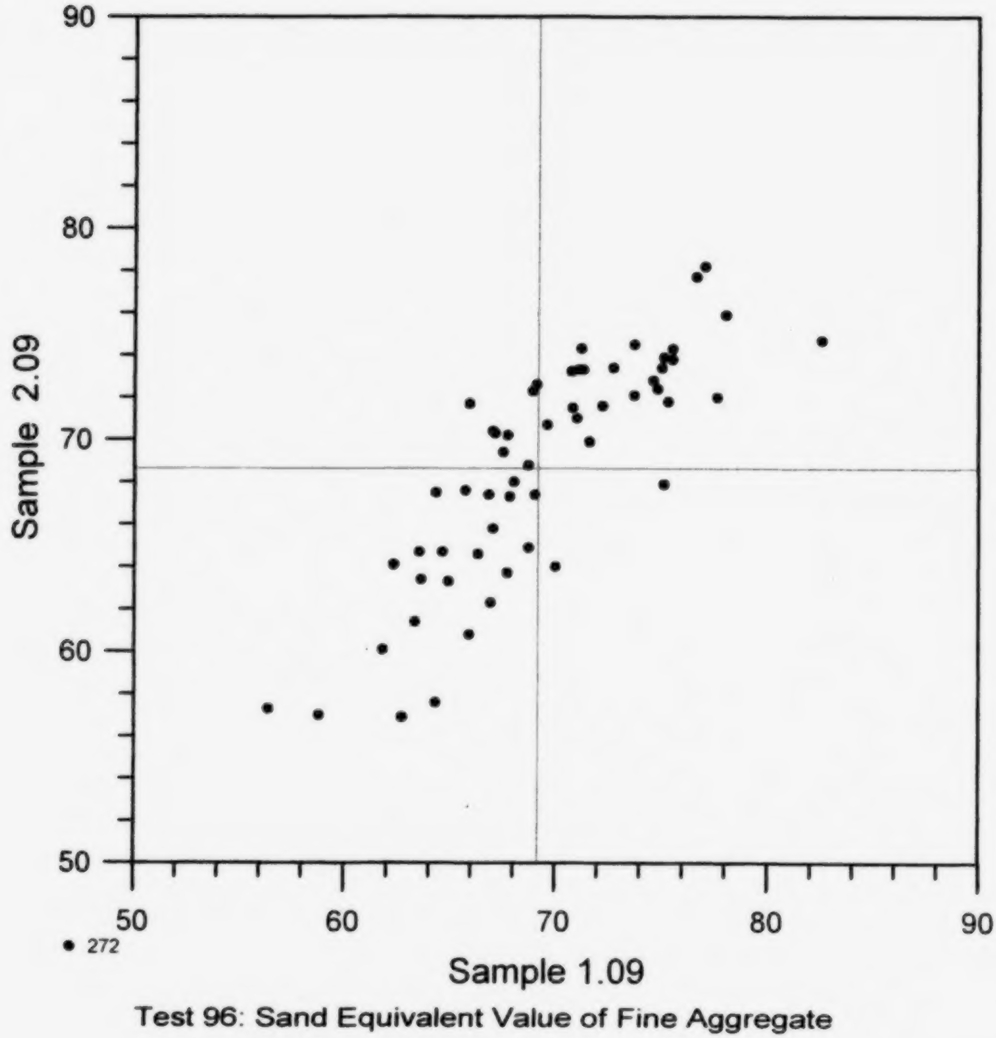
Test 95: Uncompacted Void Content of Fine Aggregate

	Mat 1	Mat 2
Mean	41.967	41.924
Median	42.100	41.950
Std Dev	0.679	0.558

n = 59

Labs eliminated: 37; 69; 115; 124

2009 MTO SUPERPAVE
CONSENSUS PROPERTY TESTING PROGRAM



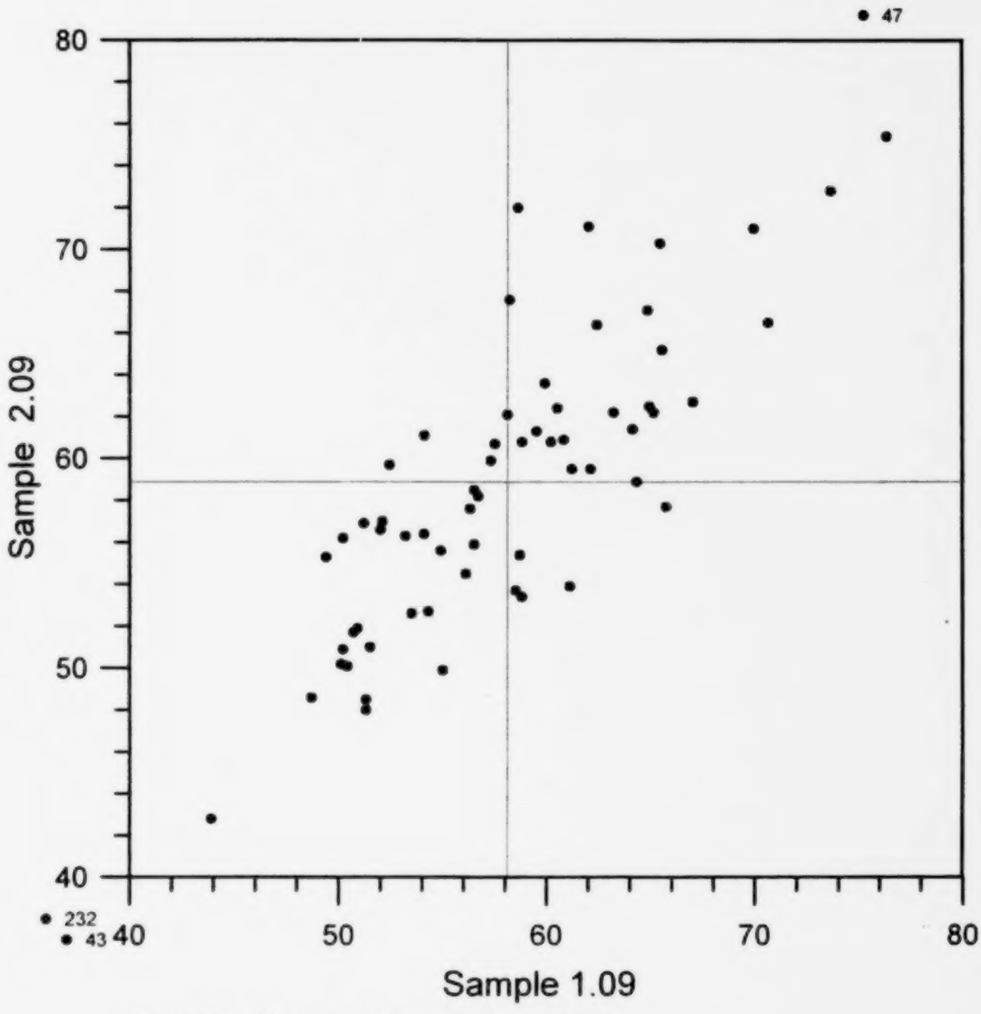
Test 96: Sand Equivalent Value of Fine Aggregate

	Mat 1	Mat 2
Mean	69.404	68.726
Median	69.450	67.550
Std Dev	5.116	5.334

n = 58

Labs eliminated: 272

2009 MTO SUPERPAVE
CONSENSUS PROPERTY TESTING PROGRAM

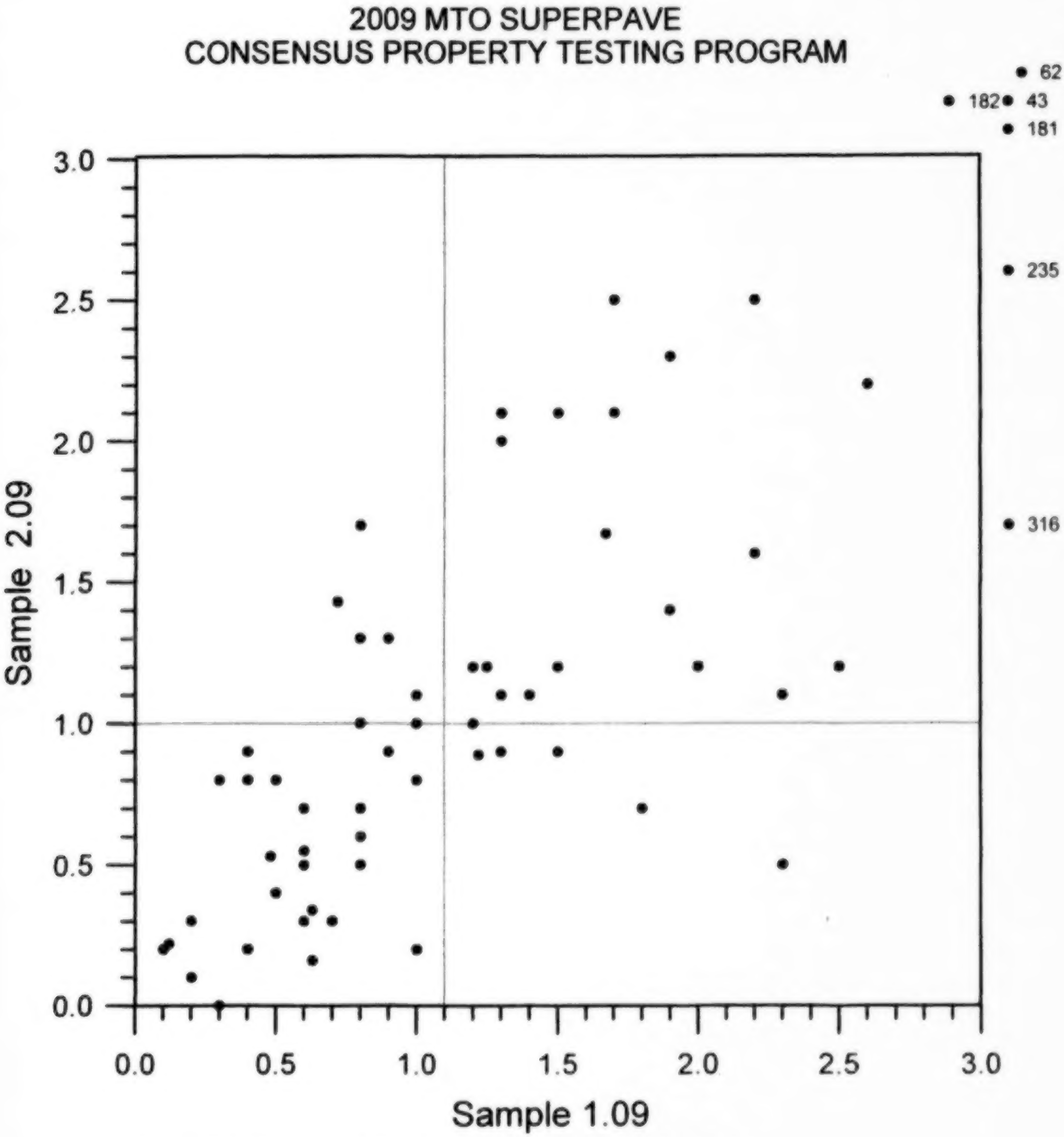


Test 97: Percent Fractured Particles

	Mat 1	Mat 2
Mean	58.344	58.780
Median	60.100	59.100
Std Dev	6.859	6.832

n = 61

Labs Eliminated: 43; 47; 232



Test 99: Percent Flat and Elongated Particles

	Mat 1	Mat 2
Mean	1.100	1.016
Median	1.350	1.250
Std Dev	0.679	0.670

n = 60

Lab Eliminated: 43; 62; 181; 182; 235; 316

Appendix E1: Production Laboratory Ratings

Lab No.	LS-601 Wash Pass	LS-602 Gradation	LS-607 % Crushed Particles	LS-621 % Asphalt Coated	LS-608 % Flat & Elongated	Rating
4	0	13.4	3	2	10	41
7	9	12.8	7	10	9	68
8	10	29.2	10	10	10	99
12	10	17.7	4	10	8	71
13	3	26.2	10	9	10	83
15	10	28.4	10	9	10	96
16	0	3.0	10	3	10	37
18	9	29.2	10	10	10	97
19	10	27.5	10	7	8	89
20	10	28.1	10	10	9	96
21	10	26.7	10	8	6	87
22	8	26.7	10	10	10	92
23	10	25.6	7	9	10	88
24	9	12.5	9	1	8	56
25	9	28.6	10	10	10	97
26	10	27.3	9	10	7	90
27	10	30.0	8	10	10	97
28	10	24.8	10	10	9	91
30	7	27.8	10	10	10	93
31	8	26.5	10	6	6	81
32	7	29.5	10	9	10	94
33	10	28.6	10	10	10	98
34	9	27.0	6	10	6	83
35	9	28.1	10	10	10	96
37	8	27.8	10	8	10	91
38	7	27.5	5	10	10	85
39	10	27.0	8	8	10	90
42	10	27.3	8	10	10	93
43	9	25.4	7	5	4	72
45	9	29.5	9	9	6	89
46	8	29.2	4	6	4	73
47	10	28.4	10	10	10	98
52	9	27.8	10	5	10	88
54	10	24.5	10	10	10	92
56	9	28.4	6	10	10	91
58	10	26.2	10	10	10	95
59	9	28.4	10	10	10	96
60	10	12.0	8	0	1	44
61	10	27.8	10	10	10	97

Lab No.	LS-601 Wash Pass	LS-602 Gradation	LS-607 % Crushed Particles	LS-621 % Asphalt Coated	LS-608 % Flat & Elongated	Rating
62	10	28.6	10	2	0	**72**
64	10	25.6	7	7	7	**81**
65	10	26.2	9	10	10	**93**
68	9	29.5	10	10	10	**98**
69	7	24.0	10	10	10	**87**
70	9	27.8	9	10	6	**88**
71	10	26.7	10	10	8	**92**
73	0	18.5	10	0	0	**41**
79	10	27.0	10	10	9	**94**
80	9	29.2	10	9	10	**96**
81	6	28.9	10	10	9	**91**
83	10	23.5	9	6	9	**82**
85	10	28.1	9	10	10	**96**
86	10	28.6	10	10	10	**98**
90	10	27.8	10	0	10	**83**
93	10	29.2	10	8	9	**95**
98	8	24.3	0	9	10	**73**
100	10	28.4	9	9	10	**95**
101	10	29.2	10	10	10	**99**
102	10	27.3	10	2	10	**85**
103	10	25.6	8	10	8	**88**
104	10	29.7	10	10	9	**98**
105	8	29.7	8	10	4	**85**
107	7	28.9	10	9	10	**93**
108	10	28.1	10	8	9	**93**
110	10	27.5	10	10	10	**96**
112	10	26.2	10	10	9	**93**
113	9	28.6	10	10	10	**97**
115	10	26.2	10	9	9	**92**
116	10	25.9	4	10	9	**84**
117	10	29.5	10	10	0	**85**
120	10	29.2	7	10	10	**95**
124	10	27.3	9	9	10	**93**
126	10	23.2	5	10	10	**83**
127	10	29.5	2	10	10	**88**
128	10	26.7	9	9	10	**92**
129	10	26.7	10	9	10	**94**
134	10	28.9	8	8	10	**93**
136	10	29.2	8	7	10	**92**
137	9	22.6	10	10	10	**88**
138	10	21.8	10	9	10	**87**
139	7	29.7	10	10	10	**95**
141	9	20.7	10	10	10	**85**
144	10	29.7	10	8	8	**94**

Lab No.	LS-601 Wash Pass	LS-602 Gradation	LS-607 % Crushed Particles	LS-621 % Asphalt Coated	LS-608 % Flat & Elongated	Rating
146	10	28.1	2	8	10	83
147	9	12.8	6	1	0	41
157	9	30.0	9	9	10	96
158	10	28.9	8	6	10	90
161	7	28.9	10	9	10	93
163	10	18.0	9	10	10	81
164	10	29.2	8	10	9	95
167	7	29.2	10	10	7	90
169	10	25.9	10	10	8	91
172	10	25.6	10	10	10	94
175	10	25.6	10	10	9	92
176	10	28.9	10	6	8	90
177	10	27.8	9	10	10	95
178	10	27.5	10	10	10	96
179	9	29.5	10	10	10	98
180	9	24.3	10	10	10	90
181	10	28.4	4	10	10	89
182	10	27.5	10	9	4	86
184	8	27.8	10	10	8	91
186	0	27.8	9	2	8	67
187	9	29.2	9	10	10	96
188	10	26.5	8	10	10	92
191	10	28.4	9	10	9	95
193	10	8.5	10	10	8	66
194	7	27.5	9	9	5	82
198	10	28.4	7	6	2	76
199	10	28.9	9	10	10	97
200	10	29.5	8	10	10	96
204	7	24.3	9	4	4	69
205	7	29.5	10	7	8	88
207	2	28.6	10	10	10	87
208	8	27.8	10	10	10	94
210	6	28.6	10	10	4	84
214	10	28.6	10	5	8	88
215	10	29.7	9	10	10	98
216	10	27.8	10	10	10	97
217	9	28.1	8	10	10	93
218	10	26.7	10	10	7	91
219	10	25.6	8	9	10	89
221	10	28.4	10	10	10	98
223	9	28.1	9	4	10	86
224	10	26.7	10	7	10	91
232	6	28.1	10	7	4	79
234	9	23.7	10	9	9	87

Lab No.	LS-601 Wash Pass	LS-602 Gradation	LS-607 % Crushed Particles	LS-621 % Asphalt Coated	LS-608 % Flat & Elongated	Rating
235	10	28.9	10	10	9	97
236	10	30.0	10	8	10	97
245	9	26.7	10	9	10	92
246	10	29.5	10	10	10	99
247	5	18.8	10	7	9	71
248	10	19.6	9	10	8	81
249	10	30.0	7	9	10	94
250	9	28.9	10	10	10	97
251	9	26.5	8	7	9	85
252	10	24.0	10	10	6	86
253	9	29.7	6	7	7	84
254	8	25.1	10	10	10	90
255	10	23.7	6	6	9	78
256	10	27.5	10	10	10	96
257	9	18.3	0	10	10	68
258	6	29.7	8	9	7	85
260	9	28.1	9	10	9	93
262	10	27.8	1	8	9	80
263	10	27.0	10	10	7	91
264	9	23.2	7	8	7	77
267	10	29.5	10	10	10	99
268	10	22.9	9	10	9	87
269	5	26.2	0	0	7	55
271	5	28.9	8	10	9	87
272	5	30.0	10	10	10	93
273	10	22.6	10	10	10	89
274	10	28.1	10	10	6	92
275	10	28.6	10	7	10	94
276	10	25.4	3	0	9	68
277	10	29.2	10	10	9	97
278	8	10.4	10	10	10	69
279	8	22.4	10	3	10	76
280	9	0.0	8	9	10	51
282	9	26.7	10	7	7	85
284	9	28.4	10	10	8	93
285	10	25.9	10	6	9	87
286	10	28.9	5	8	10	88
288	7	4.4	7	8	8	49
290	9	17.5	9	10	9	78
291	10	22.4	10	5	0	68
293	10	24.3	9	10	10	90
294	10	27.3	10	10	10	96
295	10	29.7	10	10	10	100
296	10	28.1	10	10	10	97

Lab No.	LS-601 Wash Pass	LS-602 Gradation	LS-607 % Crushed Particles	LS-621 % Asphalt Coated	LS-608 % Flat & Elongated	Rating
297	8	19.4	10	9	9	**79**
298	10	30.0	8	10	10	**97**
299	9	25.9	10	10	10	**93**
300	10	28.6	10	10	10	**98**
301	10	29.7	10	10	3	**90**
302	7	30.0	7	10	7	**87**
303	10	28.4	10	10	2	**86**
305	8	25.1	3	6	6	**69**
308	9	30.0	10	10	9	**97**
309	10	29.5	10	10	9	**98**
310	7	28.4	10	10	10	**93**
311	10	28.6	10	10	10	**98**
312	10	22.9	8	6	8	**78**
313	9	25.1	10	7	10	**87**
314	9	24.8	10	9	10	**90**
315	8	24.8	8	10	8	**84**
316	9	30.0	10	10	7	**94**
317	10	28.9	10	10	9	**97**
318	9	27.0	8	9	10	**90**
320	7	23.5	9	9	8	**81**
321	6	28.6	8	10	8	**87**
322	10	26.7	10	10	10	**95**
323	8	26.7	10	10	10	**92**
324	10	29.7	10	10	8	**97**
325	8	27.0	8	7	10	**86**
326	8	29.5	10	10	10	**96**
327	10	12.8	8	9	10	**71**
328	9	27.0	10	10	10	**94**
329	10	27.5	10	10	10	**96**
330	9	29.5	10	10	8	**95**
331	10	18.8	10	8	8	**78**
332	10	27.3	10	9	10	**95**
333	10	24.5	10	2	8	**78**
334	4	26.2	7	*10*	0	**67**
335	5	0.0	10	*6*	0	**30**
340	10	27.3	10	*10*	10	**96**

Appendix E3: Soil Laboratory Ratings

Lab No.	LS-702 Hydrometer Analysis	LS-703 & 4 Atterberg Limits	LS-705 Specific Gravity	Rating
12	9.8	6.3	10	87
15	9.6	6.7	10	88
18	9.0	9.3	10	94
19	9.2	10.0	10	97
20	9.6	7.7	10	91
22	8.2	10.0	10	94
23	9.8	10.0	0	66
24	7.4	10.0	6	78
27	9.8	7.3	10	90
28	10.0	9.3	10	98
29	10.0	8.7	7	86
30	7.4	10.0	5	75
31	8.8	10.0	10	96
32	9.6	9.0	9	92
35	7.6	9.3	10	90
37	9.2	10.0	10	97
38	8.8	5.0	7	69
46	8.8	9.7	10	95
47	7.8	10.0	9	89
54	8.6	9.7	8	88
56	8.4	10.0	8	88
58	9.4	10.0	10	98
59	8.4	10.0	10	95
64	9.6	10.0	3	75
68	9.8	10.0	10	99
69	9.6	10.0	10	99
71	9.4	9.0	0	61
72	10.0	10.0	10	100
79	9.2	10.0	10	97
80	9.4	7.3	10	89
83	9.8	9.7	10	98
86	3.8	9.7	7	68
94	9.6	8.7	10	94
98	5.8	8.3	0	47
101	10.0	10.0	6	87
102	9.2	10.0	8	91
105	8.6	10.0	9	92
112	7.8	7.0	4	63

Lab No.	LS-702 Hydrometer Analysis	LS-703 & 4 Atterberg Limits	LS-705 Specific Gravity	Rating
120	9.8	9.7	9	95
138	10.0	9.7	10	99
139	9.8	5.7	6	72
146	8.8	10.0	9	93
172	9.6	9.7	10	98
188	10.0	9.7	10	99
208	10.0	10.0	10	100
210	7.2	8.3	10	85
216	8.6	10.0	10	95
253	9.0	9.0	0	60
260	10.0	10.0	8	93
276	9.8	5.3	10	84
284	6.0	10.0	6	73
285	10.0	8.7	4	76
296	9.6	8.0	10	92
299	7.8	10.0	10	93
300	9.8	9.0	0	63
301	8.8	9.0	10	93
315	8.6	7.7	10	88
326	9.0	9.7	10	96

Appendix E4: Superpave Laboratory Ratings

Laboratory No.	C1252/T 304 Uncompacted Void Content	D2419/T 176 Sand Equivalent	ASTM D5821 % Fractured Particles	ASTM D4719 % Flat & Elongated	Rating
8	10	10	9	8	93
13	10	10	10	9	98
15	10	10	8	9	93
18	10	9	10	9	95
19	9	9	10	7	88
21	5	8	9	10	80
22	8	9	10	10	93
27	10	10	9	5	85
28	10	9	10	9	95
31	7	3	10	8	70
33	10	10	10	10	100
35	10	10	10	10	100
37	0	10	10	10	75
39	7	10	9	7	83
43	10	4	0	0	35
47	7	10	2	9	70
56	10	10	9	7	90
58	10	7	10	9	90
59	10	9	10	8	93
61	9	10	10	10	98
62	8	10	9	0	68
69	0	10	10	10	75
71	6	9	10	7	80
79	9	9	10	8	90
80	10	8	10	9	93
83	9	8	8	10	88
86	10	10	10	10	100
112	10	9	8	10	93
115	1	10	10	10	78
120	10	7	7	10	85
124	0	6	4	9	48
157	10	7	10	10	93
172	9	10	7	8	85
180	8	5	4	10	68
181	9	7	8	0	60
182	9	10	10	1	75

Laboratory No.	C1252/T 304 Uncompacted Void Content	D2419/T 176 Sand Equivalent	ASTM D5821 % Fractured Particles	ASTM D4719 % Flat & Elongated	Rating
188	10	10	8	9	**93**
193	10	10	10	10	**100**
199	10	10	8	10	**95**
215	7	10	10	8	**88**
216	9	9	8	10	**90**
236	9	10	10	10	**98**
245	9	10	10	5	**85**
253	9	7	10	9	**88**
255	10	10	6	9	**88**
263	10	10	10	8	**95**
271	7	9	7	10	**83**
272	10	0	10	10	**75**
285	10	9	9	8	**90**
293	10	9	10	10	**98**
295	9	10	10	10	**98**
296	10	10	10	9	**98**
316	4	10	10	4	**70**
325	10	10	9	10	**98**
326	7	9	10	8	**85**
327	10	9	10	10	**98**
328	9	9	8	10	**90**
340	10	10	9	10	**98**

Appendix E2: Full Service Aggregate Laboratory Ratings

FULL SERVICE AGGREGATE LABORATORY RATINGS 2009

Lab No.	LS-601 Wash Pass	LS-602 Gradation	LS-603 LAA	LS-604 BRD/ABS (CA)	LS-606 $MgSO_4$ (CA)	LS-607 % Crush	LS-621 % Asphalt	LS-608 % Flat & Elongated	LS-618 MDA (CA)	LS-614 F/T	LS-605 BRD/ABS (FA)	LS-623 One-Point Proctor	LS-619 MDA (FA)	Rating
8	10	29.2		9.5	10	10	10	10	10	10	9.0	10.0	9	**98**
13	3	26.2		10.0	10	10	9	10	6	5	9.0	9.7	9	**83**
15	10	28.4		10.0	10	10	9	10	5	8	4.0	9.7	3	**84**
18	9	29.2		8.5	10	10	10	10	10	10	9.5	10.0	8	**96**
19	10	27.5	8	9.5		10	7	8	10	10	9.5	8.0	10	**91**
22	8	26.7		10.0		10	10	10	10	8	8.0	9.3	10	**92**
23	10	25.6		10.0	3	7	9	10	10	10	10.0	10.0	4	**85**
27	10	30.0	3	9.5	10	8	10	10	10	8	10.0	10.0	10	**92**
28	10	24.8		10.0		10	10	9	8	10	10.0	10.0	10	**94**
31	8	26.5	10	6.0	10	10	6	6	10	8	9.0	10.0	10	**86**
35	9	28.1	10	9.5	10	10	10	10	9	10	10.0	10.0	10	**97**
37	8	27.8	10	9.0	10	10	8	10	10	10	10.0	10.0	10	**95**
38	7	27.5	0	7.5	9	5	10	10	9	7	8.5	9.7	9	**79**
39	10	27.0		4.0		8	8	10	5	8	9.5	9.0	8	**82**
47	10	28.4	8	10.0	10	10	10	10	10	9	10.0	9.7	10	**97**
56	9	28.4	10	10.0	10	6	10	10	9	8	10.0	10.0	10	**94**
59	9	28.4		9.5	10	10	10	10	8	10	7.5	8.7	10	**94**
61	10	27.8		7.0		10	10	10	9	10	9.5	10.0	10	**95**
69	7	24.0		10.0		10	10	10	10	10	7.5	10.0	9	**90**
79	10	27.0		10.0		10	10	9	10	10	9.5	10.0	10	**97**
80	9	29.2	10	5.5	10	10	9	10	9	0	7.5	2.3	3	**76**
83	10	23.5		10.0	10	9	6	9	3	10	7.0	9.7	7	**82**
86	10	28.6		7.5		10	10	10	10	10	10.0	3.3	7	**90**
90	10	27.8		9.5	6	10	0	10	7		8.5		9	**82**
98	8	24.3		7.0	1	0	9	10	9	0	4.5	1.0	9	**59**

Lab No.	LS-601 Wash Pass	LS-602 Gradation	LS-603 LAA	LS-604 BRD/ABS (CA)	LS-606 $MgSO_4$ (CA)	LS-607 % Crush	LS-621 % Asphalt	LS-608 % Flat & Elongated	LS-618 MDA (CA)	LS-614 F/T	LS-605 BRD/ABS (FA)	LS-623 One-Point Proctor	LS-619 MDA (FA)	Rating
101	10	29.2	10	10.0	10	10	10	10	9	9	10.0	10.0	10	**98**
105	8	29.7	5	8.5	5	8	10	4	10		10.0	10.0	10	**84**
107	7	28.9		8.5	10	10	9	10	10	10	10.0		9	**94**
108	10	28.1		7.5	10	10	8	9	10		8.0	6.7	10	**90**
110	10	27.5		10.0	10	10	10	10	10	6	10.0	9.3	10	**95**
112	10	26.2		8.5	10	10	10	9	9	9	8.5	10.0	10	**93**
120	10	29.2		6.0		7	10	10	10	10	2.5	10.0	10	**88**
124	10	27.3		6.5		9	9	10	10	10	9.5	10.0	7	**91**
157	9	30.0		8.0	10	9	9	10	7	7	10.0		10	**92**
164	10	29.2		8.0	10	8	10	9	9	10	6.5		10	**92**
172	10	25.6		9.0	10	10	10	10	8	10	10.0	9.7	6	**92**
177	10	27.8		10.0		9	10	10	10	10	10.0	10.0	10	**98**
188	10	26.5	10	0.0	7	8	10	10	10	8	8.5	10.0	10	**85**
199	10	28.9		10.0		9	10	10	10	9	9.5	9.7	10	**97**
205	7	29.5		1.5		10	7	8	1	0	5.0	7.7	5	**63**
216	10	27.8		10.0	7	10	10	10	9	10	9.0	10.0	10	**95**
245	9	26.7		8.5		10	9	10	9	8	10.0	7.0	10	**90**
260	9	28.1		10.0	5	9	10	9	9	0	5.0	7.7	9	**79**
263	10	27.0		10.0	8	10	10	7	10	10	8.5	7.3	9	**91**
285	10	25.9		10.0	9	10	6	9	8	7	10.0	10.0	10	**89**
295	10	29.7		9.5	10	10	10	10	10	9	10.0	10.0	10	**99**
296	10	28.1		5.0	10	10	10	10	10	9	8.0	10.0	10	**93**
298	10	30.0		10.0	9	8	10	10	9	10	10.0		10	**97**
301	10	29.7		9.5	7	10	10	3	9	10	9.0	7.3	10	**89**
309	10	29.5		6.0	10	10	10	9	9		9.0	10.0	10	**94**
312	10	22.9		10.0	10	8	6	8	5	5	8.0	7.3	8	**77**
316	9	30.0		10.0	10	10	10	7	10	10	8.5	9.7	10	**96**
325	8	27.0		9.0		8	7	10	8	10	9.5	10.0	10	**90**
326	8	29.5		8.5		10	10	10	10	6	6.0	5.0	10	**87**
340	10	27.3		9.0		10	10	10	10	9	9.5		9	**95**